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JOURNAL

OFFICIAL PUBLICATION

Heating • Refrigerating • Air Conditioning • Ventilating

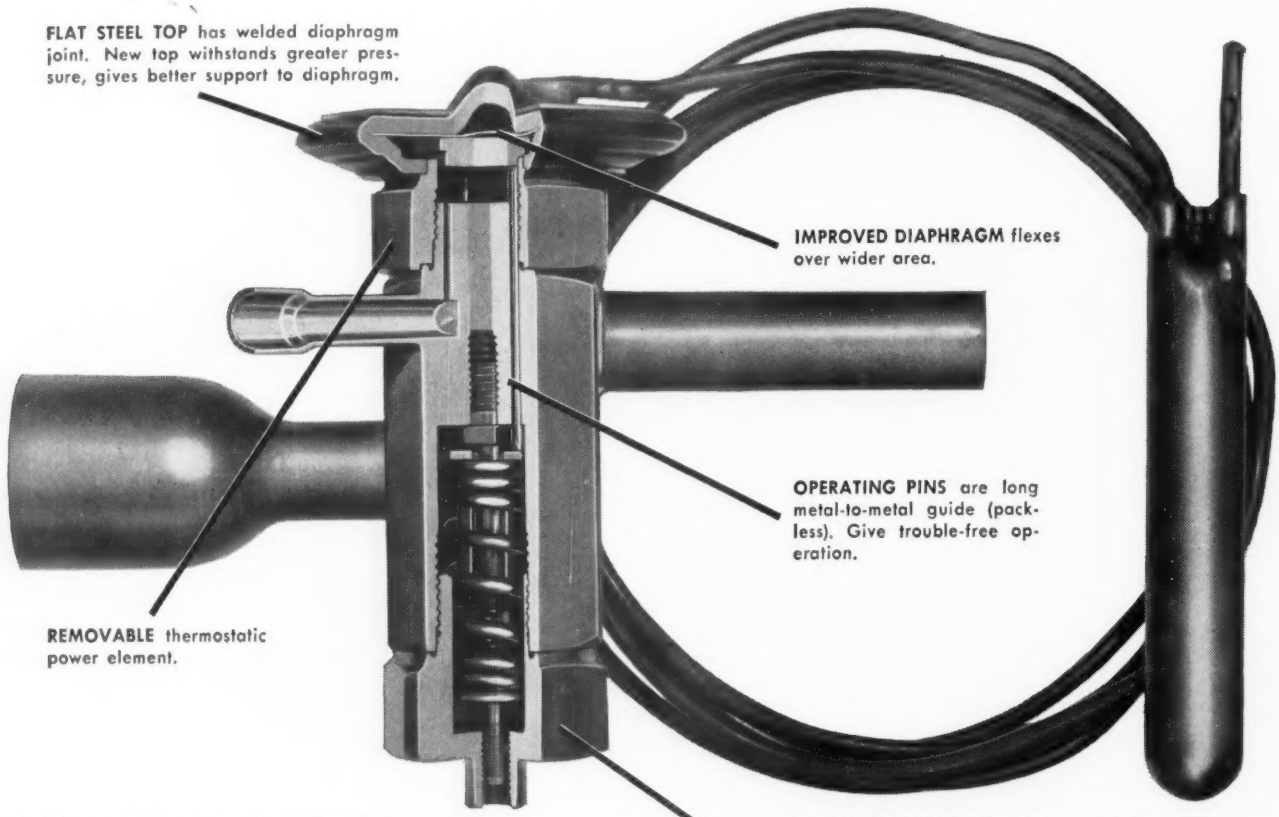
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AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS



FEBRUARY 1961

"Flat-top" valve with improved diaphragm withstands over one million normal life cycles



New A-P model 214 "flat-top" thermostatic expansion valve

This new, improved thermostatic expansion valve was built to last and last. In fact, the new model 214 "flat-top" has a life span of over 1,000,000 normal life cycles. It's the ideal valve for trouble-free replacement on large commercial applications.

Just the valve for heat pump applications, too! Sudden withdrawal of high pressure on the outlet side coupled with high thermal bulb pressure was causing tremendous strain on the diaphragm. Result: Life expectancy on some valves used on heat pump applications was as low as 7000 life cycles.

CC engineers extended valve longevity with the improvements shown above — features that enable the new "flat-top" to withstand over *100,000* life cycles of extreme pressure fluctuations incurred during heat pump reversals.

The new A-P model 214 is part of industry's most complete line of refrigeration and air-conditioning controls. Take advantage of Controls Company of America's single-source availability — your assurance of dependable performance. Write today for complete details.

Visit Booth 803 at Heating and Air Conditioning Exposition, Chicago, Feb. 13-16, 1961.

Creative controls for industry

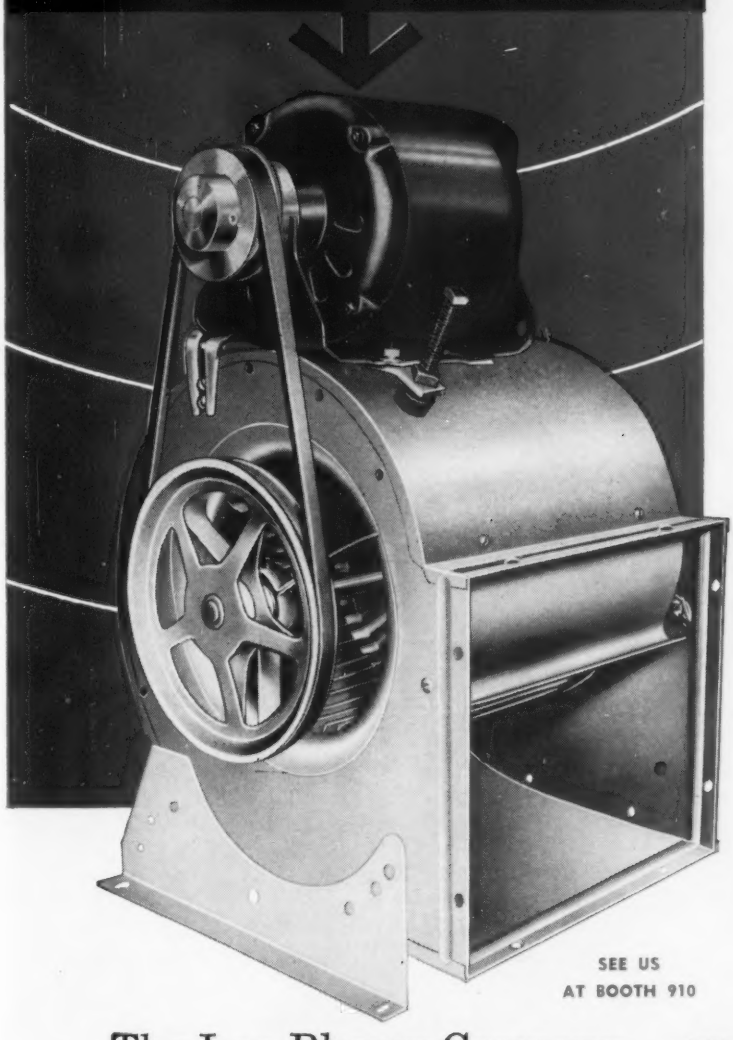
CONTROLS COMPANY OF AMERICA

HEATING AND AIR CONDITIONING DIVISION

2456 N. 32nd Street, Milwaukee 10, Wisconsin • Cooksville, Ontario • Zug, Switzerland

FEB -6 1961

SERIES A



"Features exclusive LAU FIRSTS"

Here's the most versatile blower manufactured today! The Lau Series A is extremely efficient in many applications because of its availability in such a complete performance range. Assorted wheel sizes, four standard discharge positions, and a wide selection of C.F.M. characteristics mean you can specify a blower that's practically custom made for you . . . at no extra cost.

Standard Series A features include such Lau exclusives as Preslok® wheels, ground and burnished shafting, Lau Pak Gold Seal bearings, tripod bearing brackets, heavy gauge housing supports, versatile motor mounts, and Lausteel pulleys.

Series A blower assemblies are recommended for warm air furnaces, central air conditioning systems, evaporative coolers, cooling towers, and remote condensers.

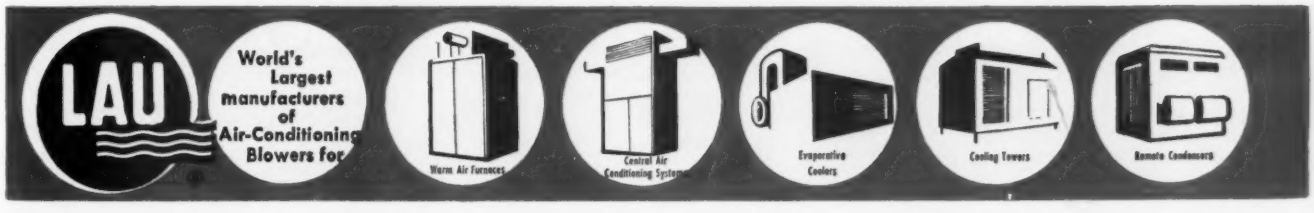
Write or call Lau today. We will place you in contact with your experienced Lau Sales Engineer. He's always nearby and ready to help you solve any air moving problem.

MEMBER INDOOR COMFORT

SEE US AT BOOTH 910

The Lau Blower Company, 2027 Home Avenue, Dayton 7, Ohio.

Other plants in Kitchener, Ont., Can., and Irwindale, Calif.



NEW DEVELOPMENT!

IN LARGE COOLING TOWERS
AND EVAPORATIVE CONDENSERS

B.A.C.

Multi-Stage Propeller-Fan Units

as **Quiet** as Centrifugal-Fan Units

with the **Low HP** of Propeller-Fan Units

Booth 39 ASHRAE SHOW

SEE IT!
HEAR IT!
COMPARE IT!

Baltimore Aircoil Company, Inc. - P.O.BOX 7322 - **Baltimore 27, Md.**

Cooling Towers and Evaporative Condensers up to 800 Tons in single factory-assembled units

FEBRUARY
1961

VOL. 3 NO. 2

OFFICIAL PUBLICATION

JOURNAL

Formerly Refrigerating Engineering including Air Conditioning, and incorporating the ASHAE Journal.

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Check these other benefits of **NEW** General Electric 30- and 40-amp starters . . .

LOWER POWER REQUIREMENTS, LONGER CONTACT LIFE

General Electric now adds the newly designed 30- and 40-amp series of contactors and starters to the present 50- and 60-amp forms. This means a complete line of rugged, compact, economical air conditioning and refrigeration controls is now available to fit your specific needs for:

- **compressor motor applications**
- **special panel mounting applications**

Here are features you'll especially like about the new 30- and 40-amp forms.

SMALLER SIZE—new contactors and starters require less mounting space than former 30- and 40-amp models. They're smaller, yet both handle applications up to 600 volts.

*CR NUMBER	MAXIMUM RATINGS					
	Full Load Amps			Locked Rotor Amps		
	220V	440V	550V	220V	440V	550V
CR154 C	30	15	15	180	90	72
CR154 D	40	20	20	240	120	96
CR154 E	50	25	25	300	150	120
CR154 F	60	30	30	360	180	144

* For starters only. Change CR number to CR153 C, D, E, and F for contactors at same rating.

POWER REQUIREMENTS REDUCED—both the new forms require only 4.5 watts, a reduction from 3.5 to 9.5 watts over previous forms. Result: a smaller control transformer can be used; lower component temperatures mean increased life, less maintenance cost.

CONTACT RELIABILITY—vertical double break silver cadmium oxide contacts shrug off dust, resist contact welding.

Still other important features include:

- **Quick trip or standard overloads**
- **Optional "push-on" coil terminals**
- **Easy three-point keyhole mounting**

SEE US AT BOOTH 736

Ask your General Electric Sales Engineer for more information, or write for bulletin GEA-7316, General Electric Co., Section 811-20, Schenectady 5, New York.

You get **MEASURABLE ADVANTAGES**
with General Electric Control

Progress Is Our Most Important Product

GENERAL ELECTRIC

EVERY B&G® COMPONENT IN THIS TYPICAL INSTALLATION IS ALIVE WITH STAR FEATURES



B&G CONDENSERS

Lighter, more compact units, featuring quiet, vibration-free operation, uniform gas distribution, cleanable tubes and higher operating efficiencies.



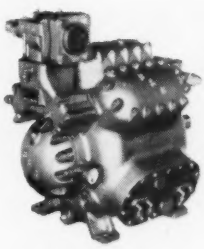
B&G EVAPORATORS

See illustration at right for features which give these units outstanding superiority.



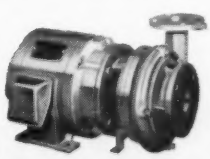
B&G SUCTION LINE HEAT EXCHANGERS

Aid thermal expansion valve operation, prevent liquid slugging.



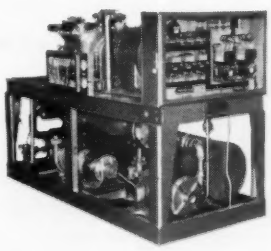
B&G COMPRESSORS

Precisely engineered for vibration-free operation with all the advantages of "open" units. All units have *one* bore —a few interchangeable parts service them all.



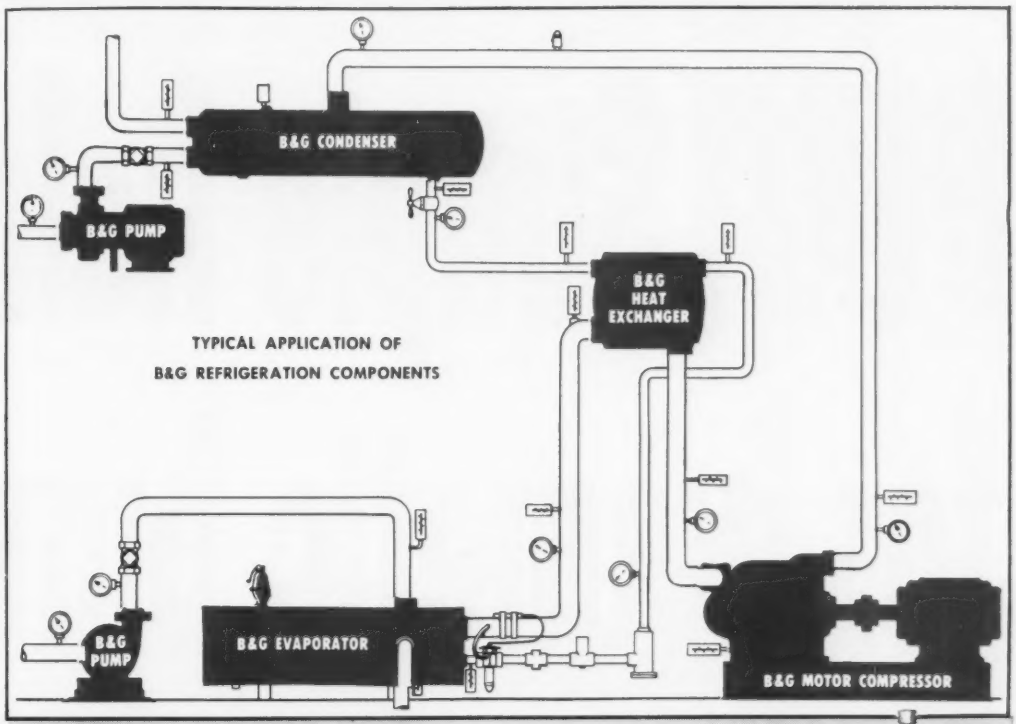
B&G CENTRIFUGAL PUMPS

A full range of *quiet* pumps for refrigeration and air conditioning systems.

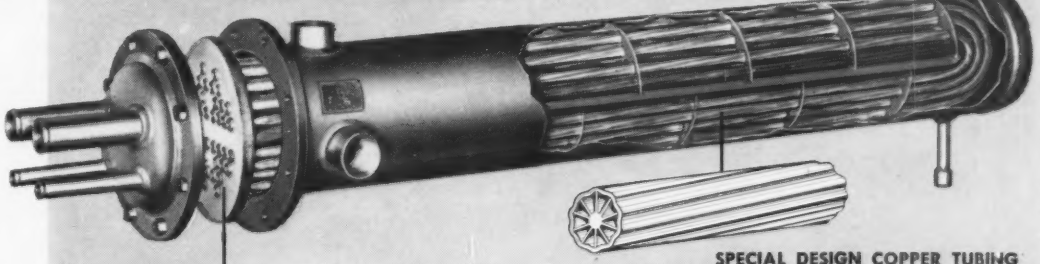


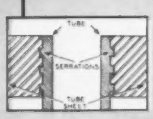
B&G PACKAGE LIQUID COOLERS

A completely integrated and assembled water chiller—the only unit of its kind with all major parts designed, built and guaranteed by one manufacturer.



"REF" EVAPORATOR...Featuring non-slugging design...tube bundle proof against freeze-up damage...positive oil return.





SERRATED TUBE HOLES
Assure leak-free joints between tube sheet and tubes

SPECIAL DESIGN COPPER TUBING

Fluted tubing provides positive and permanent mechanical bond between tube and inner fin for all temperature variations—positive contact throughout 180° bend. Inner-fin tube triples refrigerant heat transfer surfaces. Centrifugal force created by the twisted spline holds liquid refrigerant against tube, minimizing slugging and pressure drop.

B&G makes a complete line of refrigeration and air conditioning components—*with many commonly used sizes available for immediate shipment from factory stock!*

These are quality units throughout! B&G Evaporators and Condensers all offer *plus values* in efficiency and rugged, long-life construction. They are manufactured by methods which hold shell diameters exact and free of distortion. This permits tight fitting baffles with minimum liquid slippage, greater efficiency and easy replacement of tube bundles if ever necessary.

All units are built to A.S.M.E. Code requirements and are so stamped.

When selecting pumps, B&G Series 1522, 1531 and 1510-B Centrifugal Pumps invite your most critical comparison. They are of vertical split case design, equipped with the exclusive, leak-proof "Remite®" Mechanical Seal and noted for quiet, dependable operation.

BELL & GOSSETT
COMPANY
Dept. GN-64, Morton Grove, Illinois

Canadian Licensee: S. A. Armstrong, Ltd., 1400 O'Connor Drive, Toronto 16, Ontario

Coming soon from

NEW! Simple field test for hermetic burnouts

plus

NEW! Easy way to clean out mildly contaminated systems

Full information on these important new developments—plus test kits and pressurized cylinders of "Genetron" 11—will be available from your wholesaler about March 15. See him then!

General Chemical

General Chemical takes the guesswork out of hermetic burnouts

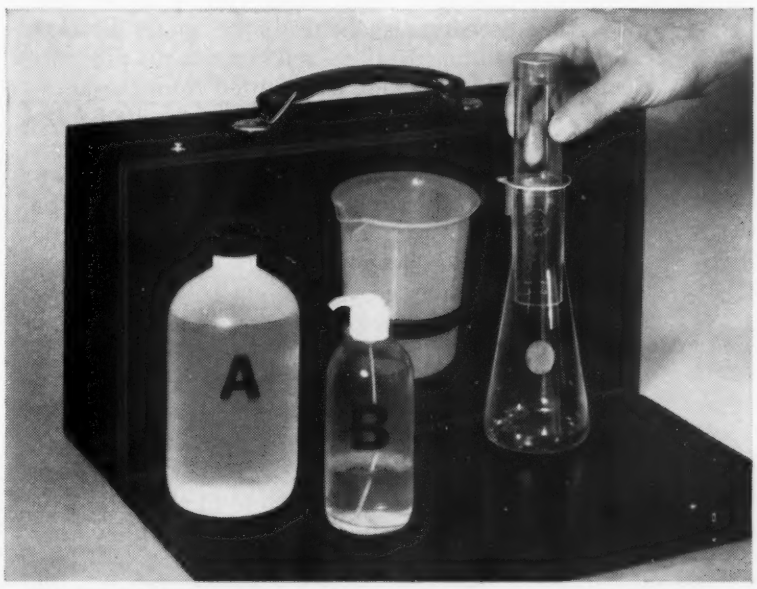
One of the oldest and toughest service problems in the refrigeration and air-conditioning industry has been licked!

Until now, there was no quick, on-the-spot test to determine the degree of acidity in a system after hermetic burnout . . . and there was no easy way to tell when the acid in a system had been cleaned out.

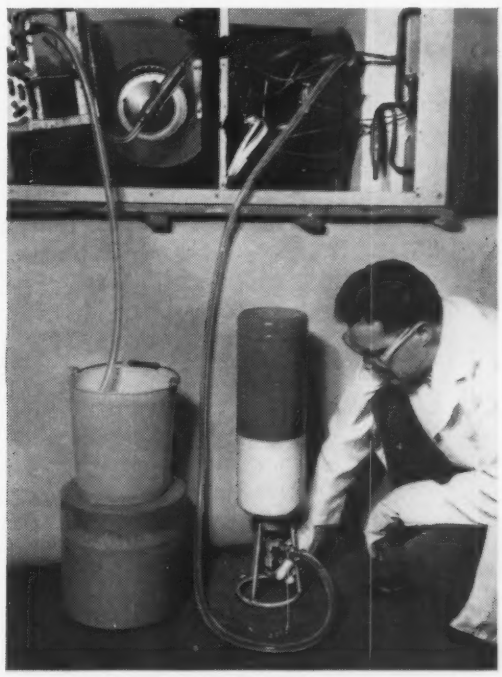
To solve this problem, General Chemical has developed the first simple field test for checking degree of contamination in a burned-out system—before and after cleanout. Yes – we've taken the guesswork out of hermetic burnouts.

In addition, General Chemical has developed an easy, short-cut procedure for cleaning out mildly contaminated systems by using pressurized cylinders of "Genetron" 11 to flush the unit – quickly and without pumping.

See how these new developments can save you time, labor and material costs:



First practical field test method! With this handy, portable kit developed by General Chemical, you can now quickly and easily determine extent of contamination in a system after hermetic burnout. Simple tests show extent of burnout contamination and what clean-up procedure should be used. Also show when cleaning is complete.



New quick, easy way to clean minor burnouts! Mildly contaminated systems can now be flushed and cleaned without pumping by using special new pressurized cylinders of "Genetron" 11 solvent. Prepared especially for flushing burnouts, these pressurized cylinders will soon be available from your wholesaler. An excellent solvent, "Genetron" 11 flushes acids and moisture, loosens and removes solids and is safe to handle.

Here is still another contribution by General Chemical to the advancement of the air conditioning and refrigeration industry. These new procedures will be demonstrated at the International Heating & Air-Conditioning Exposition, Chicago, February 13-16, at "Genetron" Booth #43 . . . and will be shown to RSES and other groups throughout the country in weeks to come.

genetron®
super-dry refrigerants

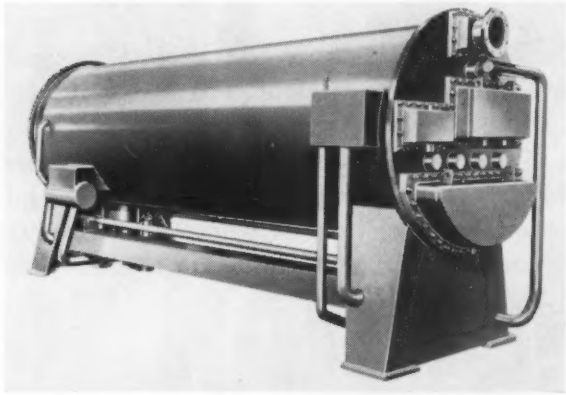
Allied Chemical

GENERAL CHEMICAL DIVISION
40 Rector Street, New York 6, N.Y.

PARTS AND PRODUCTS

ABSORPTION REFRIGERATION MACHINES

Three new sizes of absorption "Cold Generators," in capacities of 400, 455 and 530 ton, have been intro-



duced by this manufacturer. These new units expand the line to 12 basic sizes in the 100 to 530-ton range.

Featured is the same single-shell, hermetic design as that introduced in the original nine sizes in 1959. Single-shell arrangement reduces machine height, permitting installation in low-ceiling areas. Hermetic design prevents air leakage, thus maintaining full-rated capacity and resisting internal oxidation. In addition, units are completely automatic.

Trane Company, La Crosse, Wisc.

DOOR HEATERS

For use to protect against cold drafts through plant shipping doors when they are open and to supplement the plant heating system when doors are open, Vari-Jet discharge door heaters are available in ten sizes for mounting heights to 22 ft and floor area coverage up to 60 x 132 ft, mounted for room heating, or 33 x 180 ft, mounted for perimeter heating. Steam or hot water may be used as the heating medium.

Heater automatically provides a high-velocity curtain of warm air when a door opens, to penetrate and temper inrushing cold outside air. When the door closes, a damper is repositioned for discharge of warm air at normal velocity, to provide either room or perimeter heating under room thermostat control. In summer, the fan may be operated without heat to promote air circulation.

L. J. Wing Manufacturing Company, 2300 N. Stiles St., Linden, N. J.

COMPRESSOR PROTECTORS

Improved motor-compressor overtemperature protection, especially for compressors that have used dome-mounted controls, is offered with recently developed internally-mounted protectors and motor winding thermostat-supplementary overload systems. Klixon hermetic protectors, sensitive to both current and temperature, can be mounted internally inside the compressor shell, adjacent to the windings, so as to follow the winding temperature closely and protect the capacity of the motor.

Several design features, different from those used on regular open-type protectors, are utilized in construction of hermetic protectors. Disc and contacts must be isolated from the refrigerant atmosphere, where arcing contacts would cause a breakdown in the gas. Terminals come from a hermetically-sealed can through glass-to-metal insulating seals and the can is welded to the terminal header. A variety of sizes and capacities is available to cover a range of compressor ratings from ½ to 5 hp, single phase, and 2 to 7½ hp, three phase.

Texas Instruments, Inc., Metals & Controls Div, Spencer Products Group, 34 Forest St., Attleboro, Mass.

ELECTRICALLY-DRIVEN FANS

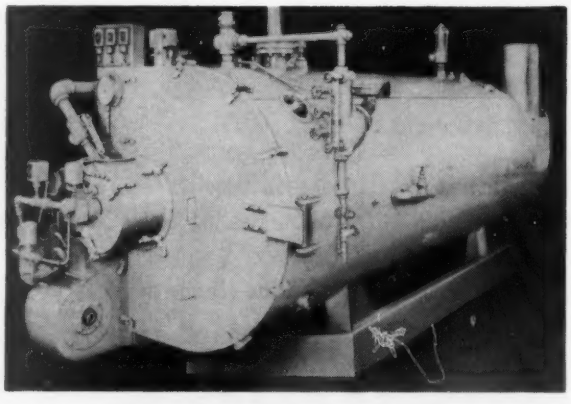
Designed to be as compact as possible with regard to floor space, Piggy-Bak fans are equipped with motors mounted on the fan housing. Motors are mounted on a heavy bed plate with bolts, so that when the discharge is changed, the motor bracket can be repositioned. Resilient mounting prevents electrical hum from being transmitted from the housing to the duct work. Adjustable motor bases are provided for belt tightening.

Either backward curve non-overloading or quiet-operating forward curve-type fan wheels may be provided, giving a wide range of capacities and static pressures. Furnished with ball bearings as standard equipment, units can be supplied also with non-ferrous parts to make them spark or corrosion-resistant.

Champion Blower & Forge Company, Inc., Dept 9, Lancaster, Pa.

POSITIVE FLOW BOILER

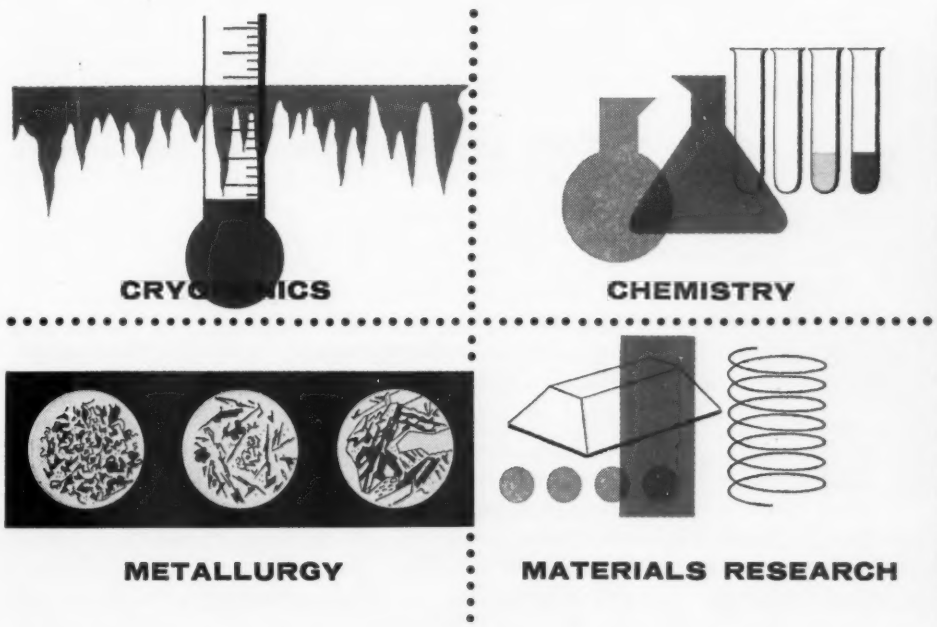
Considerably different from previous models, this new boiler, designated Powermaster Positive Flow, has burner and furnace located on the left side at the horizontal center line of the boiler. It is of three-pass design with no tubes directly above or below the



furnace, thus avoiding any impediment to natural circulation flow. Design of the unit permits boiler

UNION CARBIDE announces a new personalized assistance program for air conditioning and refrigeration equipment manufacturers. Through your UCON Brand Refrigerants representative, CARBIDE offers you the experience of hundreds of specialists in cryogenics, metallurgy, chemistry and materials research.

Can CARBIDE technology help you find better lubricants? Help you solve special corrosion problems? Assist you in developing plastics and elastomers? See your UCON Refrigerants representative... and find out how this new personalized assistance program can work for YOU!



A new 96,000 square foot laboratory at Tarrytown, N. Y. will be an important part of CARBIDE's new assistance program. In this building, scientists and technicians from all areas of Union Carbide Chemicals Company's wide-ranging activities will pool their research experience to help you find practical answers to your problems. Your UCON Refrigerants representative makes this concentrated experience available to you, through CARBIDE's personalized assistance service. See him, soon! Call, write or wire UCON Refrigerants, Union Carbide Chemicals Company, 270 Park Avenue, New York 17, N. Y.

UNION CARBIDE
UCON
BRAND
refrigerants

These 5 UCON Brand Refrigerants will meet your refrigeration and air conditioning needs

UCON Refrigerant 11 Trichloromonofluoromethane
UCON Refrigerant 12 Dichlorodifluoromethane
UCON Refrigerant 22 Monochlorodifluoromethane
UCON Refrigerant 113 Trichlorotrifluoroethane
UCON Refrigerant 114 Dichlorotetrafluoroethane

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UNION CARBIDE CHEMICALS COMPANY *Division of Union Carbide Corporation*
270 Park Avenue • New York 17, New York

feed injection and natural thermal circulation to augment each other to provide efficient heat transfer.

Circulation pattern is comparable to that in a watertube boiler. It develops as relatively cool water is directed down through the third pass, then rises through the second pass and around the furnace. In addition to the positive circulation feature, other benefits cited include elimination of danger of heat damage from stagnant water and sludge at the bottom of the boiler, fireside and waterside surfaces are easy to inspect and turn-around spaces may be simple and accessible.

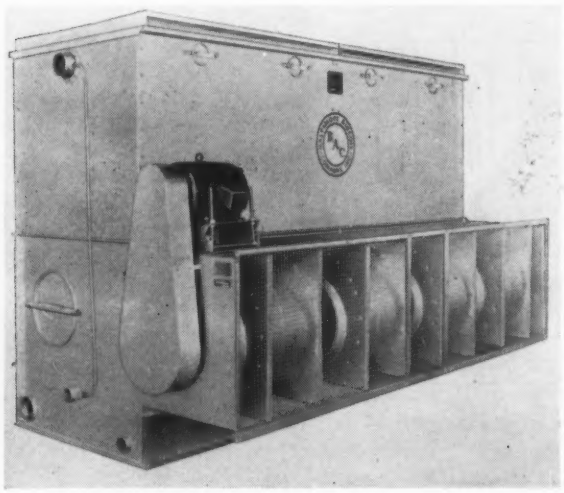
Other features incorporated in the boiler are: hinged front cover with quick-opening fasteners, rear cover hinged and divided for easy accessibility and maintenance, back construction available with either standard dryback or optional wetback and liner may be replaced in the field, if necessary.

Dryback design utilizes a new pre-fired high temperature liner, backed with a light-weight insulating material, to provide high resistance to flame and assure minimum refractory maintenance. Wetback is interchangeable with dryback.

Orr & Sembower, Inc., Reading, Pa.

150-TON COOLING TOWERS

Two new 150-ton blow-through cooling towers are offered by this manufacturer. One is a standard, quiet-operating centrifugal-fan tower, one of the 1960 line of models from 10 to 800 ton; the other is a



newly developed multi-stage propeller-fan tower that combines low-operating hp with centrifugal-fan quietness. Shown is the standard unit, Model TMA.

Baltimore Aircoil Company, Inc., P. O. Box 7322, Baltimore 27, Md.

PIPE HANGER

One-piece clamps, automatic alignment, interchangeability of pipes within a bank without moving adjacent pipes and a wide variety of clamp sizes are features of this hanger for banks of pipe. Clamps are small in bulk and nest together for easy handling.

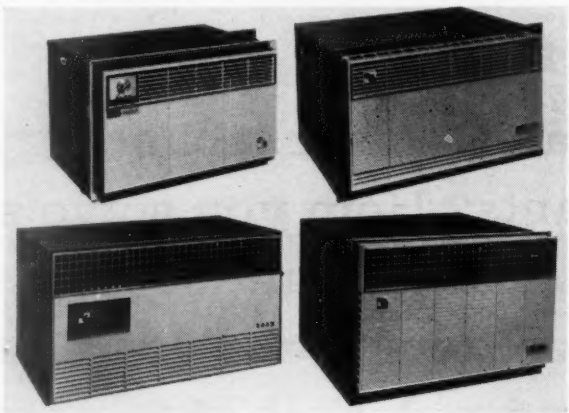
Pipe is held against a channel iron by spring alloy aluminum clamps which slide over the pipe and are held by slots in the channel. Cams on the clamps hold them in place.

Stamperhanger Company, 1634 Telegraph Ave., Oakland 12, Calif.

1961 AIR CONDITIONERS

Here shown are four models introduced for 1961. At top in the illustration are the Adventurer (left) and Discoverer (right), and at bottom are the Builder's Model (left) and Conqueror (right).

Push-button control and improved performance



are featured on the Adventurer for 1961, which has an acoustic floating front, internally-sealed compartments and cushion-mounted fans and compressor to absorb vibration and sound for quiet operation. Two filters are provided, one for return room air and the other on the outside air intake. Most compact model in the line, the Adventurer is one of the smallest high-performance units offered.

Wide-range comfort control and quiet operation suit the Discoverer for window or through-the-wall installation. Featuring dual cooling speeds for heavy duty daytime cooling and quiet nighttime operation and dual fan speeds for control of either exhaust, filtered fresh air or circulated and filtered room air, the unit also automatically maintains the preselected temperature. Reverse cycle models with supplementary electric heating are available for chilly spring or fall days.

Combined in the Builder's Model are features not previously available in through-the-wall or window air conditioners. The casing of baked enamel on zinc-grip steel may be installed at any time during or after the building operation, with the heavy-duty conditioning unit inserted as needed. By depressing two catches, the entire front panel may be removed, and the sliding control cover has no hinges or springs. Simplified controls provide a wide range of fresh air, exhaust and thermostatically controlled cooling.

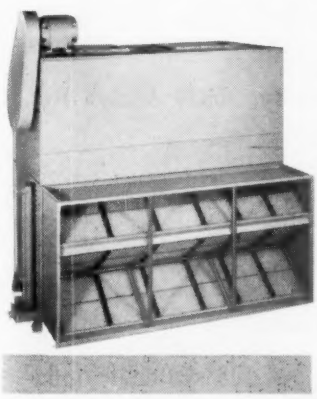
Highest performance unit in the line is the heavy-duty Conqueror. Full range controls permit wide choice of the amount of fresh air, exhaust, fan speed and cooling temperature. Reverse cycle units provide heat for fall and autumn days. Available in the Power Surge Conqueror is an automatic timer which permits setting the unit at up to 45 min of "overdrive" for rapid lowering of room temperatures. At the end of

There's something NEW in AIR HANDLING UNITS . . .



DUNHAM-BUSH "COMPACTS"

for COOLING • HEATING • HUMIDITY CONTROL



SEE US AT BOOTHS 32 & 38
15th INT'L HTG & AIR CONDG. EXPOS. INT'L AMPHITHEATER, CHICAGO
FEB. 13-16, 1961

Compact modern design means lower shipping costs, lower installation costs, less required equipment area, more rigid assembly. Thirteen case sizes are available . . . in either floor or ceiling mounted units, with an over-lapping range of air deliveries.

Dunham-Bush Air Handling Units the "compact line" of the industry offers the architect, engineer, and contractor a diversified selection of central station units. Dunham-Bush Air Handling Units are available with direct expansion, water or steam coils . . . or in combinations of these coils.

The Dunham-Bush-engineered flexibility of the component parts assures delivery of air, conditioned to fulfill any seasonal or product demand. Air can be filtered, cooled and dehumidified; or filtered, heated and humidified . . . depending on the requirement.

Accessory equipment available includes mixing boxes, filter sections, face and by-pass dampers for close humidity control, and both water and steam spray humidifiers.

A wide range of air outlet locations and motor arrangements makes Dunham-Bush Air Handling Units easy to specify—easier to install.

DUNHAM-BUSH

DUNHAM-BUSH, INC.

WEST HARTFORD 10, CONNECTICUT, U. S. A.

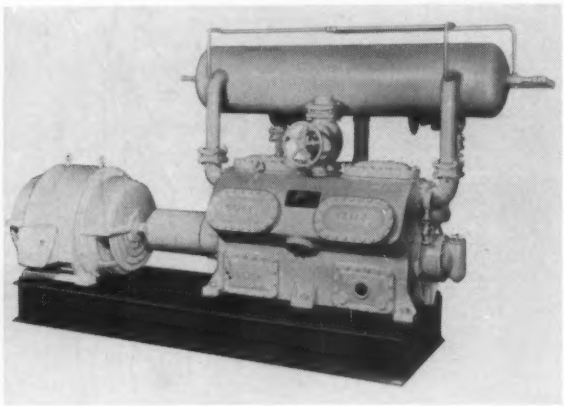
SALES OFFICES LOCATED IN PRINCIPAL CITIES

the selected time, the air conditioner resumes its preselected high or low cooling operation.
York Div, Borg-Warner Corporation, York, Pa.

TWO-STAGE COMPRESSOR

Broadening its line of two-stage VMC compressors, this manufacturer has introduced a 12-cylinder model to supplement a 6-cylinder unit introduced earlier. With these two units, a range of from 6 to 40 ton of refrigeration is possible, depending upon operating conditions. Offered for direct-connected or V-belt drive, two-stage VMCs can be supplied for operation with ammonia and Refrigerant 12 and 22.

For a variety of applications, the two-stage model is suited especially for use where a processing function requires low temperature refrigeration and cost or floor limitations prevent selection of individual booster and high-stage compressors.



Vilter Manufacturing Company, Milwaukee, Wisc.

POLYURETHANE SEALANT

For a wide variety of industrial uses, 829-901 Black U.I. Sealant is a soft, high-modulus composition which is applied easily with either a caulking gun or a knife. It is offered in a single package, requires no field mixing or curing accelerators and does not shrink on aging. Adhesive properties are excellent and will withstand changes in temperature within a range of –75 to 150 C.

Flexible on aging, the sealant has good resistance to chemicals and serves as a barrier protection between dissimilar metals. Even in joints as wide as ¾ in. it will not slump or sag in vertical or overhead installations. Film-forming urethanes in the material provide a tough skin in one to three days, and the compound is cured to a durable, elastic rubber in 10 to 14 days.
E. I. du Pont de Nemours & Company, Wilmington, Delaware.

DEHUMIDIFIERS, PURIFIERS

Model DA-3 contains an air purification system consisting of two germicidal lamps in addition to two large, activated charcoal filter cells to remove dust, dirt and other airborne particles as well as soot and odors. It can operate in conjunction with, or separately from the dehumidifier. Also incorporated in this model are such features as "Automatic Humidistat," which turns the unit off or on according to a pre-set level of humidity desired; "Overflow Guard," which turns the unit off automatically to prevent overflow; and "Overflow Signal Light," which lights up when the bucket is full.

Two additional Quiet Kool dehumidifier models, DA-2, which contains all the features of DA-3 with the exception of the air purifier, and DA-1, are offered also.
Emerson Radio & Phonograph Corporation, Jersey City 2, N. J.

REFRIGERATED TRUCK BODY

Compact, light-weight and insulated, this truck body is available in eight or ten-ft lengths for one and one and one-half-ton chassis, respectively. Step-in door permits drivers to work inside with the door closed at drop points, eliminating temperature loss due to open doors and providing easy access to all points of the body for quick loading and unloading.

Refrigerating unit is a Model C-5 Cargo Cooler comprised of a plate coil and a hold-over plate and mounted on the front wall of the body. Compressor is belt-driven from the vehicle engine. When the engine is operating, air is drawn by a blower across the super-chilled surface of the plate coil and then circulated throughout the body. Refrigerant which has not absorbed completely its Btu capacity freezes the hold-over plate, which continues to refrigerate the body when the vehicle engine is not operating. Need for standby power is eliminated by the hold-over plate system. These plates are available in two thicknesses, a one-in. plate for maintenance of safe temperatures overnight and a two-in. plate for longer periods.

Even distribution of refrigerated air to all points of the body is accomplished by a thermostatically-controlled forced-air circulation fan. When the door is opened, a door switch automatically stops the fan, reducing heat loss and protecting the person entering from low-temperature air blast.
Hunter Manufacturing Company, 30539 Aurora Rd., Cleveland 39, Ohio.

DISC-TYPE THERMOSTAT

Application of a line voltage heater built into a small thermostat is found in the Klixon 20450 Series, designed primarily for control systems in appliances. One use is in clothes dryers, where input to the built-in heater is varied by an adjustable switch to influence the natural response of the thermal element to ambient temperature, providing a means of control for damp dry or full dry cycles.

Construction can be varied to some extent to meet specific needs; however, the basic thermostat is small in size, measuring 1.181 in. diam by 1.131 in. high and weighing approximately one oz. Unit is supplied with a single-pole, single-throw contact arrangement in two contact structures: as a fan switch (circuit closes on temperature rise) and as a

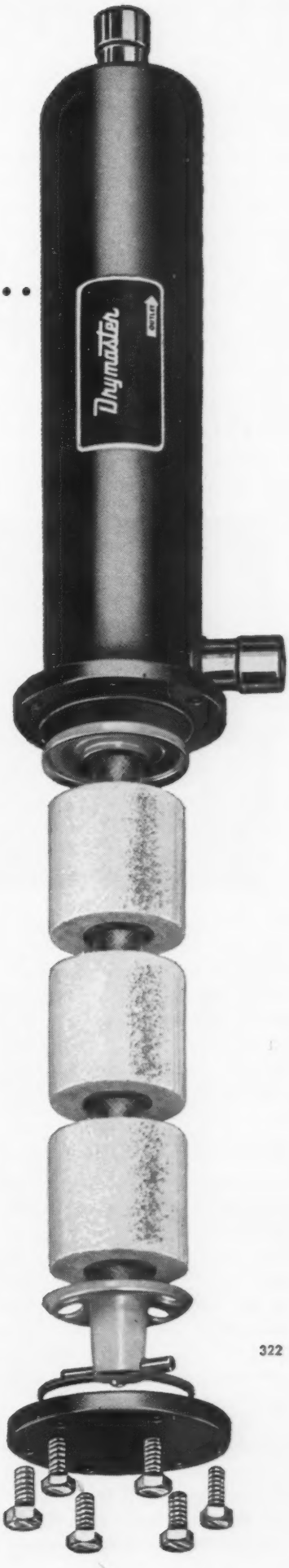
UNSURPASSED FILTERING AND DRYING with ADDED Convenience and Economy... It's the New Refillable Type *Drymaster*® Filter-Drier!

The superb, balanced filtering and drying performance of the new refillable type DRYMASTER comes from HI-FI Filter Block Desiccant: These fully activated, pressure molded briquettes quickly remove all harmful moisture, acid, sludge and micron-size foreign particles from the refrigeration system. HI-FI Filter Block Dessicant is non-dusting, non-channeling and is virtually unequalled in moisture adsorbing capacity. Its combination surface and internal depth filtering ability is unsurpassed by any other comparably sized drier in the field today.

And the new angle-type, refillable DRYMASTER Filter-Drier gives added convenience and economy, too. Once installed, the body shell of the Drier is in for the life of the system; only the desiccant is replaced. DRYMASTER Refillable Filter-Driers are designed for 5 ton through 165 ton capacities with ½" O.D. through 2⅛" O.D. solder connections. End fittings are made of copper for easier soldering.



HI-FI Desiccant Briquettes, protected against shock by fibre glass padding, come packed in vacuum sealed cans ready to be installed quickly, easily, with no connections or joints to remake.



Write today for Catalog R-159 . . . contains complete information on all Streamline Refrigeration and Air-Conditioning products.

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VAMPCO ALUMINUM PRODUCTS, LTD., STRATHROY, ONTARIO
Exclusive Canadian Representative for Mueller Brass Co.
Air Conditioning and Refrigeration Products

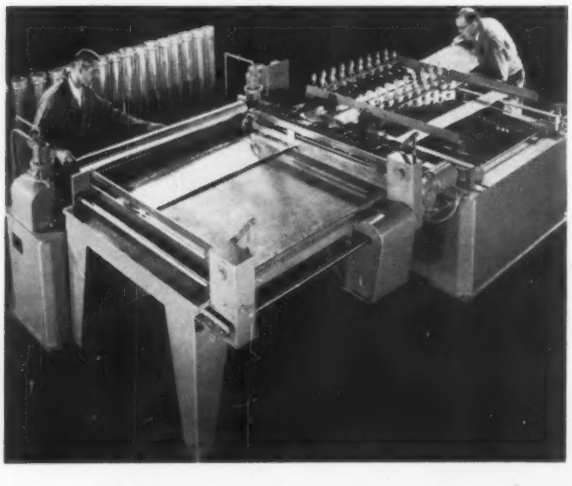
high limit switch (circuit opens on temperature rise). The thermostat is avaialble also with single-pole, double-throw switching action.

Operating characteristics are: max ambient temperature, 200 F; current rating (terminals 1 and 3), 25 amp, 120/240 volt ac, resistive, and 13 amp/120 volt ac, 10 amp/240 volt ac, FLR; 60 amp/120 volt ac, 45 amp/240 volt ac, LRA; current rating (terminals 1 and 2), 10 amp/120 volt ac, 5 amp/240 volt ac, resistive, and 5.8 amp/120 volt ac, 2.9 amp/240 volt ac, FLR; 34.8 amp/120 volt ac, 17.4 amp/240 volt ac, LRA. Max heater rating 5 watt; max heater voltage 120 volt ac.

Texas Instruments, Inc., Metals & Controls Div, Spencer Products Group, 34 Forest St., Attleboro, Mass.

FEED TABLE

For high-speed production of pipe and duct sections, this feed table automatically transfers panels from



the snap-lock machine to the roller machine, making possible snap-lock forming, rolling, beading and crimping in one continuous rapid operation. Automatic transfer also permits operation of the snap-lock and roller machines at high speeds for maximum production.

Maplewood Div, Rockford Machine Tool Company, Rockford, Ill.

HEATING-COOLING UNITS

Cooling portion of the 365 Conditionair unit includes a cooling coil placed in the heating system's air stream and a condensing unit placed outside the building. Cooling section alone may be installed in homes not equipped with forced air heating systems. Capacities of the air conditioning units range from two to five ton. With maximum over-all dimensions of 28¾ x 45⅝ x 31⅞ in., the compact remote condensing units are weatherproof and designed for easy installation and servicing.

Gas furnaces are 4½ ft high and 2¼ ft deep, with widths ranging from 14 to 23 in. Input capacities range from 70,000 to 125,000 Btu/hr. Oil furnaces, 4½ ft high and 3 ft deep, range in width from 23 to 31 in. and have input capacities from 67,000 to 112,000 Btu/hr. Both types of furnace will be offered in three model groupings: Highboy, designed for installation in utility rooms, closets or corner locations; Counterflow, suited for homes without basements or those using perimeter systems; and Horizontal, for low attic areas, crawlways and underfloor hanging.

Delco Appliance Div, General Motors Corporation, Rochester 1, N.Y.

GLASS-DOOR FREEZER

Glass doors of the swing-out or sliding type are featured with automatic hot gas defrosting in a new 45-cu ft freezer and a refrigerator recently introduced. Also included in this expanded line are a freezer, refrigerator and combination refrigerator-freezer with solid doors. All units are equipped with moisture vaporizers to eliminate the need for drains.

Operating at zero to −10 F, the freezer is designed primarily for display of frozen products. Four-ply glass doors of the unit are self-closing to reduce heat gain. Heavy heater strips surround each door opening and the entire frame to prevent condensation on the cabinet's exterior. Circulating air keeps the glass clear and interior lights improve visibility.

Nor-Lake, Inc., Second and Elm Sts., Hudson, Wisc.

AIR DISTRIBUTION SYSTEM

Acousti-Flo System, a new low-velocity method of introducing conditioned air into a room, has been developed by this manufacturer. Combined in this ceiling system are a glass fiber air supply tube and a perforated metal bar diffuser which distributes air evenly throughout a room. Purpose of the system is to combine positive delivery of air through self-insulated tubes with full wall-to-wall diffusion to minimize dead air spots. Air delivery is controlled by adjusting continuous dampers.

Owens-Corning Fiberglas Corporation, 717 Fifth Ave., New York, N. Y.

CARGO REEFER DOORS

Weight savings of 1500 lb per cold storage doorway are cited as being provided by plastics cargo reefer doors. Designed for minimum weight and improved insulation without sacrificing strength, these doors have heavy-gauge galvanized sheet steel baffles to protect against damage by cargo. Baffle bars are secured firmly to the doors and insulated to prevent heat conduction and minimize condensation and frost on exposed metal parts. Compression and sweeper gaskets along door edges prevent cold air leaks and reduce heat loss. All through rods have thermal breaks.

Outer shell of these doors is glass fiber reinforced polyester. Fire-resistant and impervious, the material possesses rigidity plus a slight resilience that improves its resistance to impact damage. Foamed-in-place polyurethane plastics inside the doors has excellent insulation value and is five-in. thick for greater protection.

Jamison Cold Storage Door Company, Hagerstown, Maryland.



SIMPLIFY LOW-TEMPERATURE SILVER BRAZING WITH THESE SPECIALLY DEVELOPED FLUXES!





The correct selection of flux can offer unexpected help in speeding and simplifying production, minimizing rejects and lowering costs in low temperature silver brazing operations. The advantages to be gained by "selective fluxing" are *sufficiently important to warrant careful, thorough study!*

Silvaloy offers the most advanced flux developments in this specialized field. Here, is *a complete line of fluxes . . .* each providing outstanding performance, enabling you to select the correct flux for every possible low temperature brazing operation. The extra efficiency of Silvaloy "Selective Fluxing" is being proved daily on the brazing production lines of the country's leading manufacturers.

Call the Silvaloy distributor in your area for consultation and detailed information or, send for our booklet "A Complete Guide to Selective Fluxing for Low Temperature Silver Brazing."

Silvaloy fluxes are packaged in 65-lb. and 30-lb. drums, 5-lb. wide mouth jars (5 to a carton), 1-lb. and ½-lb. jars. The wide opening of the 5-lb. package makes it a most practical, time saving dispenser that also enables the operator to make use of every bit of flux in jar.















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Krack standard refrigeration units fill rigid specifications at U.S. Air Force Academy

New Air Force Academy at Colorado Springs . . . a showplace . . . functions as a completely efficient physical plant. Equipment and refrigeration systems in all buildings were planned, constructed and installed to assure long life, economical and automatic operation.

Specification requirements for 31 refrigerated areas at 7000′ altitude

Temperature range: –5 to plus 60° F.
Relative humidity: 50 to 92%.

KRACK *standard* production line models met these, plus other specification requirements. This is one of many cases where KRACK'S wide selection of *standard* units filled every refrigeration requirement. 9 times out of 10 you'll find that *standard* KRACK units fill your needs without expensive modifications.

KRACK safety margins assure deliverance of capacities as rated—no need to over specify!

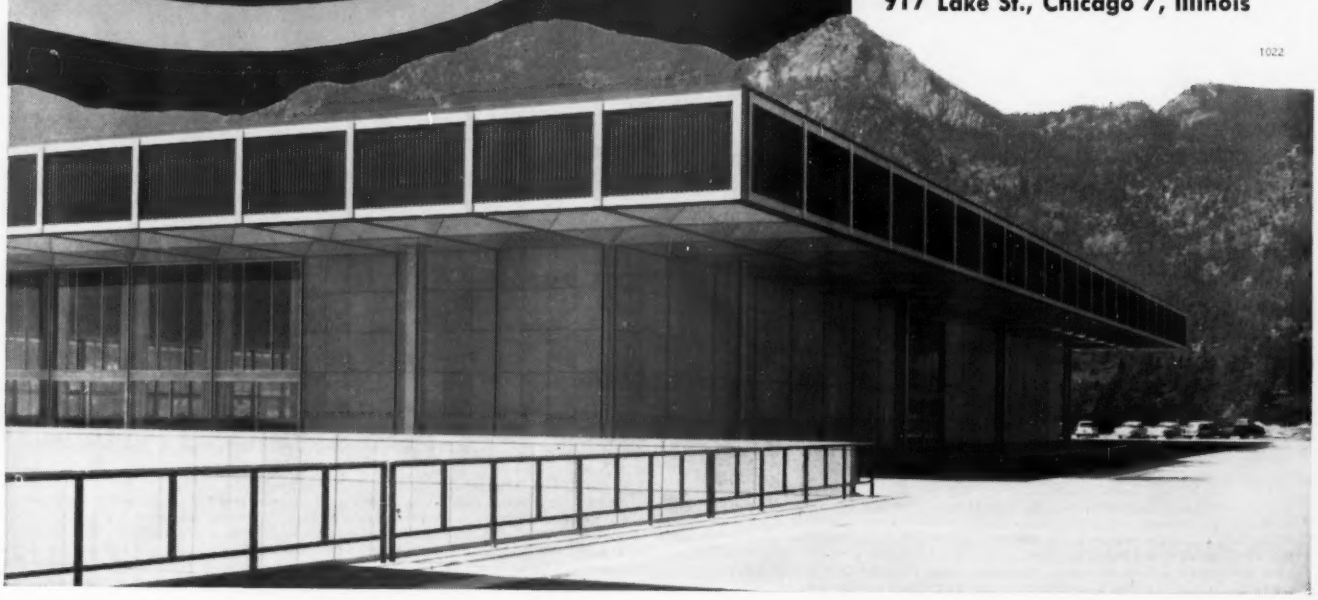
Write for data on complete installation and catalog 600!

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REFRIGERATION APPLIANCES, INC.
917 Lake St., Chicago 7, Illinois

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News highlights of the month

TRENDS

Nitrogen cooling Reporting upon tests with a single frozen food distributing truck using liquid nitrogen to maintain the truck area at a low temperature, the U.S.D.A. Agricultural Marketing Service indicates that the refrigerant was spread directly on the load. It is stated that once the desired temperature was established, it was easy to maintain and that during the five-day test period the material warehoused at 12 F achieved last delivery at 9 F.

Automatic heat According to K. L. Wilson, vice president of Minneapolis-Honeywell Regulator Company, there were 24,000,000 automatically heated homes in the United States at the end of 1960. This was an increase of 1,286,000 over the previous year and marks the 75th anniversary of automatically controlled residential heating equipment.

1960 employment There were more than 800,000 scientists and engineers employed in January 1960 as compared with 764,000 similarly allied with business firms in January 1959, according to a current survey of the National Science Foundation. This 7% rise compares with a 5% increase from 1958 to 1959. More than 10,000 companies cooperated to furnish data for the report which will appear in final form early this year.

By mail Allegedly the first to be offered by a major university, a nation-wide correspondence course to aid engineers to prepare for professional registration, "Engineering Fundamentals" has been developed for the University of California by Lloyd M. Polentz. Further information may be obtained from the Department of Correspondence Instruction, University Extension, University of California, Berkeley 4, Calif.

Air conditioning school Marked by the attendance of 170 students who heard 20 lecturers in the course of a five-day program, the 1960 Gas Air Conditioning Sales School was held in December under the auspices of the Air Conditioning and Heating Committee of the American Gas Association. Topics covered included: Definitions, design and performance of reciprocating and centrifugal compressors, absorption machines, boilers, humidity controls and similar factors leading to matters of sales instruction.

BOOK REVIEWS

Air pollution "National Goals in Air Pollution Research" is a 40-page report of the U. S. Surgeon General's Task Group. Issued by the U. S. Department of Health, Education and Welfare, Washington 25, D. C., the report recommends determinations of the effects of air pollution on human health and the agricultural economy, the finding of better ways of measuring economic losses from air pollution and other research upon meteorological factors.

Building products As announced by the American Institute of Architects, preparation of the second edition of the AIA Building Products Register has been started and publication is scheduled for early 1961. It is stated that this edition will list almost twice as many products as did the 1960 volume and in augmented categories.

Business training National Warm Air Heating and Air Conditioning Association, 640 Engineers Bldg., Cleveland 14, Ohio, has prepared a comprehensive Management Reference Guide for use in the business training program of that organization. This comprehensive text is a general reference to the warm air heating and cooling industry specifically compiled for contractor-dealer levels.

ECPD Covering the interval to September 30, 1960, the 28th Annual Report of Engineers' Council for Professional Development is a 70-page review of the activities of the Guidance Committee as well as of other groups within this organization. A feature is a review of accredited curricula leading to first degrees in engineering in the United States in 1960. This covers a large group of reporting instructions and certain paralleling courses.

ICR Proceedings Issued in three volumes, proceedings of the 10th International Congress of Refrigeration covered a wide area on the specific references to low tem-

peratures, heat transfer calculations, insulation materials, refrigeration machinery and air conditioning. Pergamon Press Ltd., Headington Hill Hall, Oxford, England.

With honors? Providing some alarmingly frank survey results, "Engineering Professionalism in Industry," issued by the National Society of Professional Engineers, 2029 K Street, N.W., Washington 6, D. C., is the sixth in a series. This 104-page volume seeks to evaluate thoroughly the engineer's own feelings as to his professional status and as to his relationship with industrial management. $4.00.

Building research Deriving from the 1959 Fall Conference and the 1960 Spring Conference of the Building Research Institute, Publication 831, "Proposals for New Building Research," is a 72-page introduction to contemplated projects for better understanding of important projects within this field. Building Research Institute, 2101 Constitution Avenue, N.W., Washington 25, D. C. $4.00.

SPECIAL MEETINGS

ARI not ASHRAE Contrary to certain references recently published elsewhere, the 12th Exposition of the Air Conditioning and Refrigeration Industry, to be held in Los Angeles, February 12-15, 1962, is under the auspices of the Air Conditioning and Refrigeration Institute and not ASHRAE. As reported here, previously, the Western Air Conditioning Industries Association cancelled its arrangements for a 1962 show to cooperate as hosts for the ARI exposition. The ASHRAE show is, of course, being held this month in Chicago in conjunction with our Semiannual Meeting. The next ASHRAE show will be in 1963 in New York.

Professional climate Representatives of educational institutions and industrial organizations will meet in Cincinnati, February 2-3, for the 13th Annual College-Industry Conference concentrating upon the development and maintenance of the professional climate in engineering. This conference is sponsored by the Relations with Industry Div of the American Society for Engineering Education.

Warehousers Concentrating upon management problems, the business program for the 70th annual meeting of the National Association of Refrigerated Warehouses will be held in San Francisco March 26-30. Panel discussions will cover various operational and technical aspects in the handling of frozen foods and some aspects of automation.

INDUSTRY CHANGES

Recold won When the NLRB certified the election in which Recold employees rejected three separate union claims to represent, a 233-day strike of this California air conditioning and refrigeration manufacturer came to an official end. Meanwhile, Recold rebuilt a production staff from a residual 12 of an original 253, expanded its operations in California and elsewhere and maintained its high wage and working conditions policy.

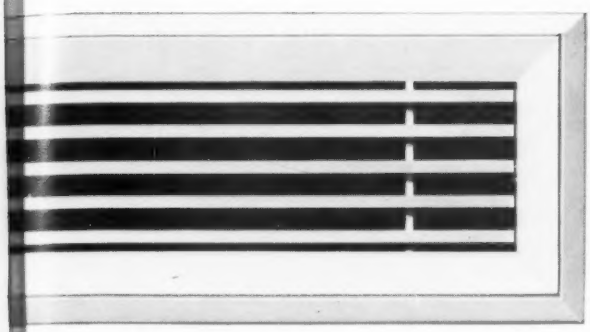
Cooling towers Formation of an Associate Membership Section of the Cooling Tower Institute, 1120 West 43rd St., Houston 18, Texas, inclusive of owners and operators of industrial water cooling towers, has been announced simultaneously with the 1961 Annual Cooling Tower Institute Meeting. Held in January, in New Orleans, technical committee meetings included such matters as fogging, altitude and salt water effects upon performance, theoretical projects, psychrometry, wood maintenance, plastics and similar factors. As the general meeting field performance test data were evaluated by John C. Campbell of the Hudson Engineering Corporation, corrosion resistant materials for tower hardware were probed by Wesley Smith, Oregon State College.

Controls research Establishment of a new corporate research and development staff to carry out basic and applied research projects for the Controls Company of America has been announced with the objectives of developing new ideas that can become the basis for product projects of various divisions and subsidiaries of that organization. Over-all direction of this corporate research group is headed by Chairman Roy W. Johnson of the Controls Corporation.

March	Report Issue with news of the Semiannual Meeting, pictures of speakers and of social events and honor awards.

Tuttle & Bailey Air Distribution Equipment

IMPERIALINE EXTRUDED ALUMINUM GRILLES



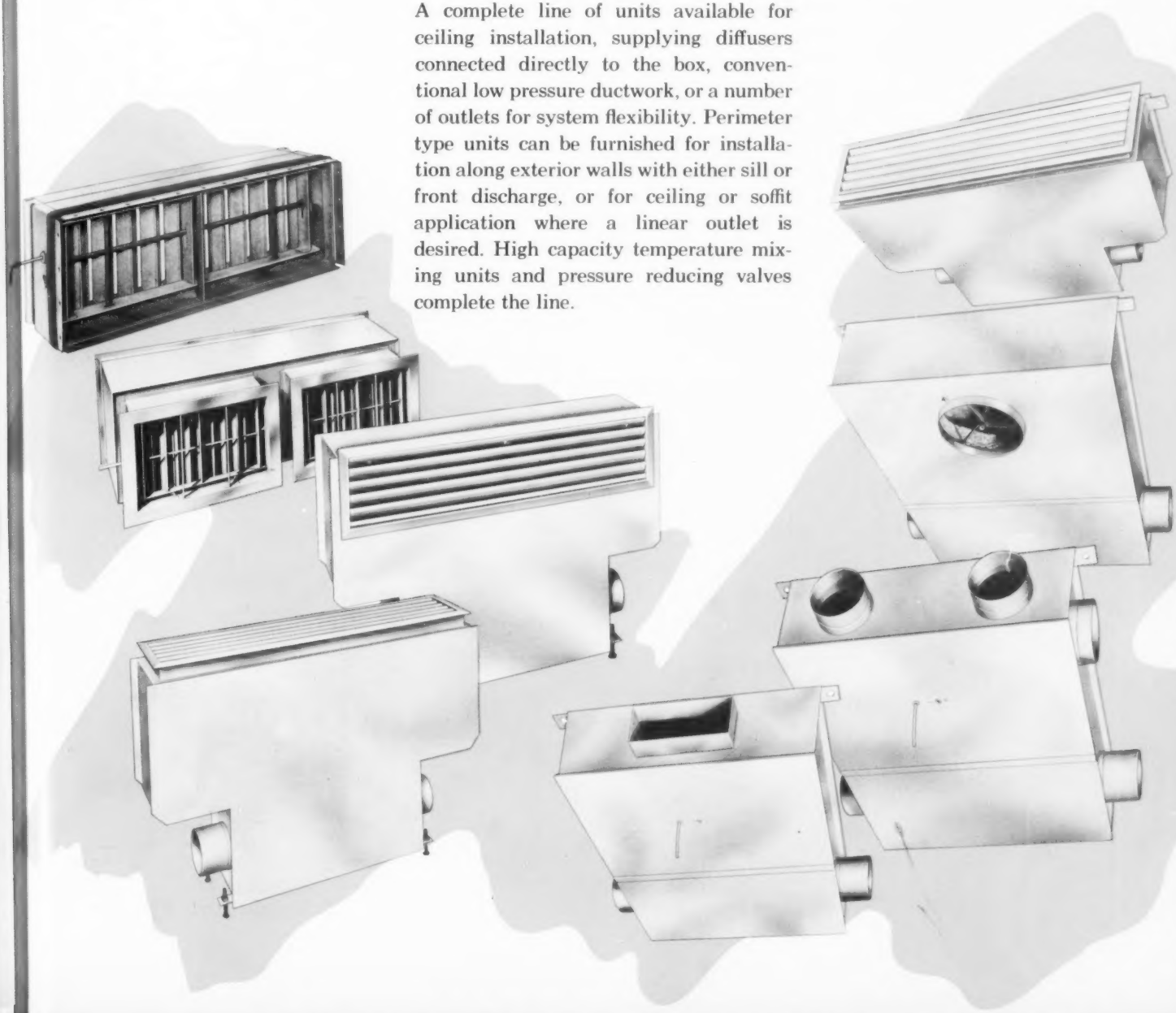
Designed to harmonize with or accent linear design concepts . . . may be used for supply or return on heating, cooling, or ventilating systems . . . ideal for ceiling, sidewall, floor, or sill installation.

Six margin styles. Can be furnished in one-piece construction up to 72″ x 48″ where the 72″ dimension can be either length or height . . . available in listed sizes of 1½″, 2″, 2½″, 3″, 4″, 5″ and in 2″ increments from 6″ through 72″.

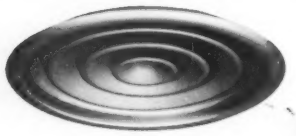
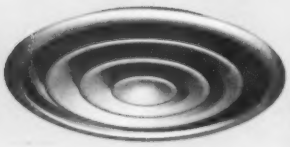
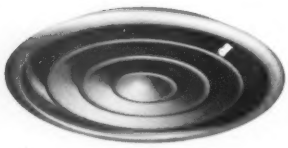
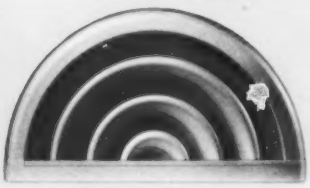
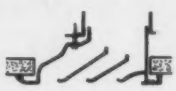
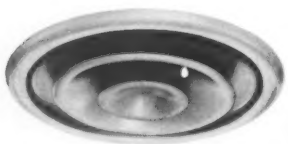
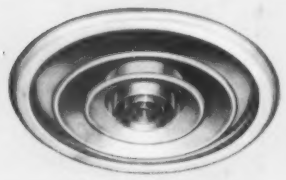
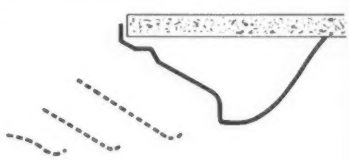
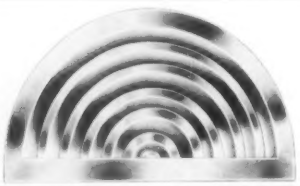
Bars can be furnished set straight, deflected 15° or 30°. A pencil-proof is also available.

HIGH PRESSURE EQUIPMENT

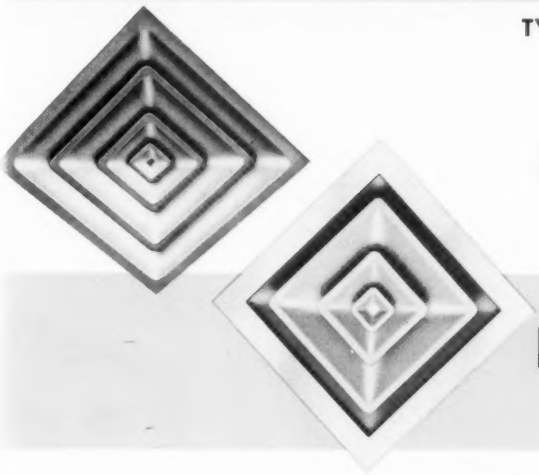
A complete line of units available for ceiling installation, supplying diffusers connected directly to the box, conventional low pressure ductwork, or a number of outlets for system flexibility. Perimeter type units can be furnished for installation along exterior walls with either sill or front discharge, or for ceiling or soffit application where a linear outlet is desired. High capacity temperature mixing units and pressure reducing valves complete the line.



Ceiling Diffusers – Round

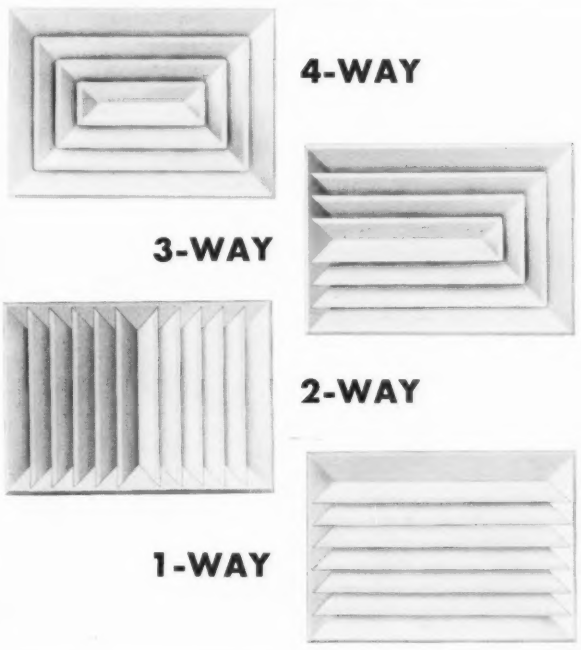
TYPE	CROSS-SECTION	DESCRIPTION	APPLICATION	LISTED SIZES
 **PA**		Adjustable Pattern (Full)	Ceiling or Exposed Duct	6-8-10-12-14-16-18-20-24-30-36
 **PS**		Stepped Down, Fixed Pattern	Ceiling or Exposed Duct	6-8-10-12-14-16-18-20-24-30-36
 **PF**		Flush, Fixed Pattern (also available with light fixture — Type PLF)	Ceiling	6-8-10-12-14-16-18-20-24-30-36
 **PH**		Flush, Fixed Pattern, Half-Round	Ceiling	6-8-10-12-14-16-18-20-24
 **P3**		Adjustable Pattern (4 position)	Ceiling or Exposed Duct	6-8-10-12-14-16-18-20-24-30-36
 **PR**		Flush, Fixed Pattern, Supply and Return	Ceiling	8-10-12-14-16-18-20-24-30-36
 **P-1**		Deep Outer Shell	Alternate outer shell for all Type P Diffusers	6-8-10-12-14-16-18-20-24
 **S**		Flush, Fixed Pattern	Ceiling	6-8-10-12-15-18-21-27-33-38
 **H**		Flush, Fixed Pattern, Half-Round	Ceiling	8-10-12-15-18-21-27-33-38
 **ES**		Stepped Down, Fixed Pattern	Ceiling or Exposed Duct	6-8-10-12-15-18-22-27-33

Ceiling Diffusers – Square and Rectangular



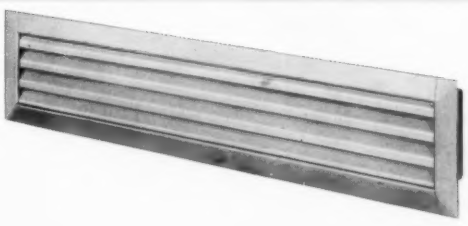
TYPE	DESCRIPTION	APPLICATION	LISTED SIZES
D	Fixed Pattern	Acoustical tile, exposed duct, or overlap ceiling.	6-8-10-12-15
DA	Adjustable Pattern	Ceiling or Exposed Duct.	6-8-10-12-15
DFP	Panel	Acoustical tile or T-bar.	6-8-10-12-15

TYPE M MULTI-PATTERN DIFFUSERS

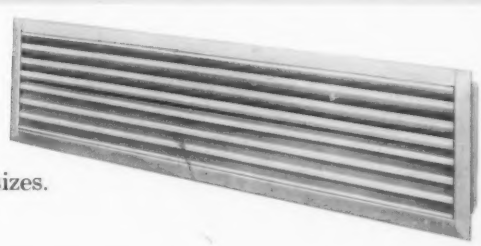


AIR PATTERN ARRANGEMENTS	MARGIN STYLE	APPLICATION	SIZES
4-WAY	MS-Beveled	Overlap ceiling	3 inch increments from 6 x 6 to 36 x 36
3-WAY	ME-Flat	Overlap ceiling	3 inch increments from 6 x 6 to 36 x 36
2-WAY	MF-Flush	Acoustical tile	3 inch increments from 6 x 6 to 36 x 36
1-WAY	MD-Drop Collar	Flush installation with surface mounted lights or exposed beams.	3 inch increments from 6 x 6 to 36 x 36

TYPE L LINEAR DIFFUSERS



One-way Blow.
3½″ and 6½″ listed sizes.

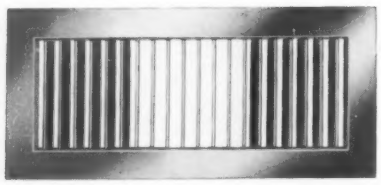


Two-way Blow.
7″ and 13″ listed sizes.

18-24-30-36-48-60-72″ lengths

Grilles and Registers

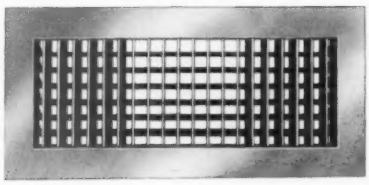
SUPPLY GRILLES



Single Deflection

T50 Horizontal Face Bars

T60 Vertical Face Bars

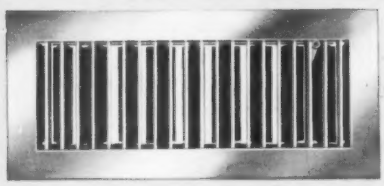


Double Deflection

T55 Horizontal Face Bars

T64 Vertical Face Bars

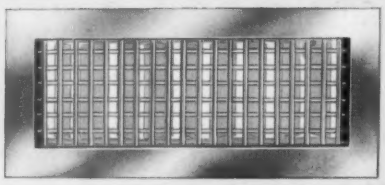
SUPPLY REGISTERS



Single Deflection

T57 Horizontal Face Bars

T67 Vertical Face Bars

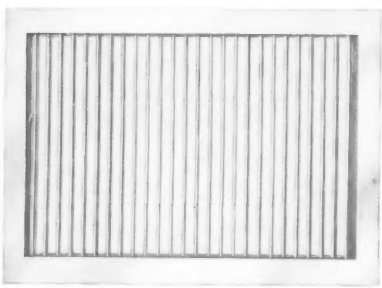


Double Deflection

T557 Horizontal Face Bars

T647 Vertical Face Bars

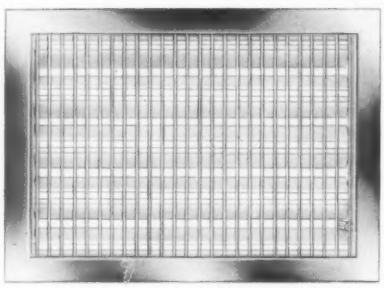
RETURN GRILLES



T70D Horizontal Bars set at 35° angle

T80 Vertical Bars set Straight

RETURN REGISTERS

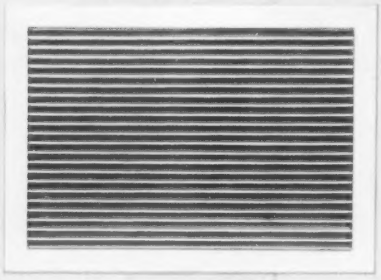


T78 Horizontal Face Bars

T88 Vertical Face Bars

RETURN GRILLES AND REGISTERS

with close-spaced bars

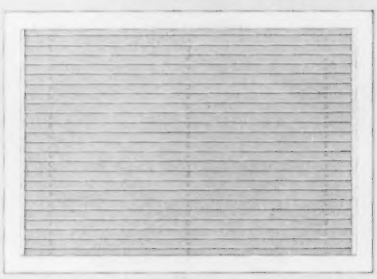


T110D — Grille — Horizontal Face Bars

T117D Register — Horizontal Face Bars

RETURN GRILLES AND REGISTERS

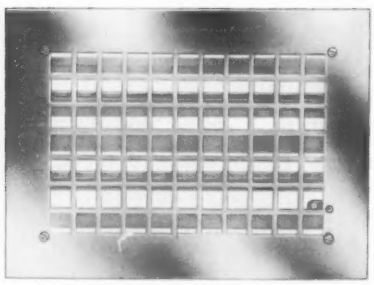
heavy-duty



T70DG Grille — Horizontal Face Bars

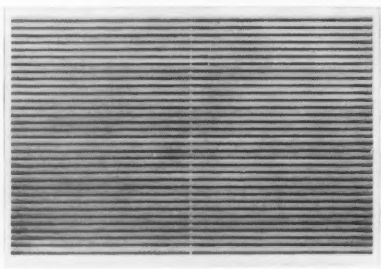
T77DG Register — Horizontal Face Bars

No. 7908 KEY OPERATED REGISTER



Also available as Slide Operated Register (No. 808)

T980 RETURN AIR AND DOOR GRILLES



Four types available with sight-tight feature

For complete catalog information on Tuttle & Bailey Air Distribution Equipment, call your nearest T&B Factory Sales Office or Representative . . . or write direct.

TUTTLE & BAILEY

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NEW BRITAIN, CONNECTICUT

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CITY OF INDUSTRY, CALIFORNIA

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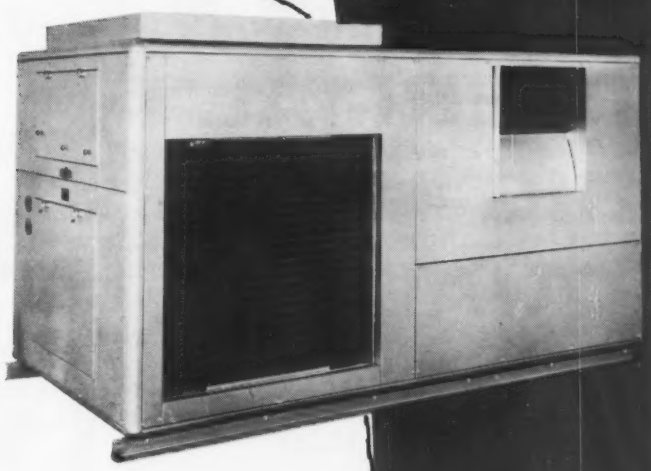
Governair

NEWEST ADDITION TO THE INDUSTRY'S LEADING SELF-CONTAINED LINE

COMPLETELY SELF-CONTAINED

AIR COOLED

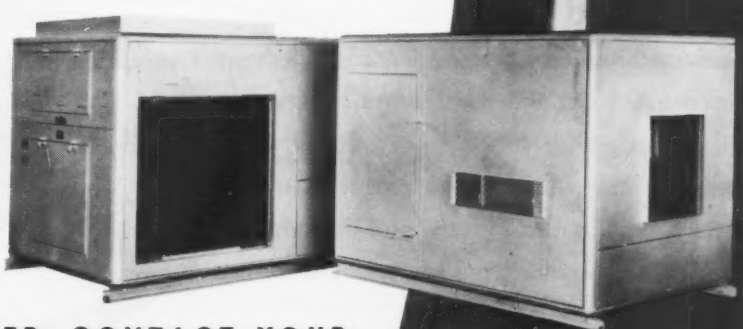
PACKAGE UNIT TYPE SCAC



GOVERNAIR'S SCAC is available in six basic models from 10 through 40 ton capacities. Typical GOVERNAIR flexibility has been maintained with a choice of 4, 5, or 6 row cooling coils offered to meet all capacity requirements. Roof mounting has been considered in the Low-Silhouette arrangement.

The basic one-piece cooling unit is housed in a rugged weatherized cabinet and mounted on rails. It is completely wired, charged and tested at the factory. Demountable and remote arrangements are available, and accessories include choice of filters, face and by-pass dampers, reduced voltage starters, Low Ambient Control, and the Gas Fired Furnace Section.

YEAR-'ROUND AIR CONDITIONING is accomplished by the use of the gas-fired furnace section. This accessory consists of a complete and unaltered gas-fired duct furnace housed in a Weatherized Cabinet with an integral by-pass damper arrangement. Refrigerated air may completely by-pass the furnace, while any desired amount of air is diverted through the furnace during the heating cycle.



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NOW!

THERMAL BIG-UNIT QUALITY

IN COMPACT EC COOLING AND HEATING UNITS

These Thermal EC Air Handling Units provide efficient and quiet cooling and heating for small stores, shops, restaurants, offices, apartment houses, and are particularly adaptable for heating units in schools and institutions. Savings in installation, operation and maintenance result from their compactness, rugged yet lightweight construction, high efficiency fans and coils, and easy access to internal components.

Available either in the "Standard" or "De Luxe" models, EC units are obtainable with 2-, 4-, 6- or 8-row direct expansion or chilled-water cooling coils, and with one or two-row hot water or steam heating coils, for year around operation. For ceiling suspension the "Standard" or "De Luxe" horizontal unit may be used. The vertical "Standard" unit is designed for floor mounting.

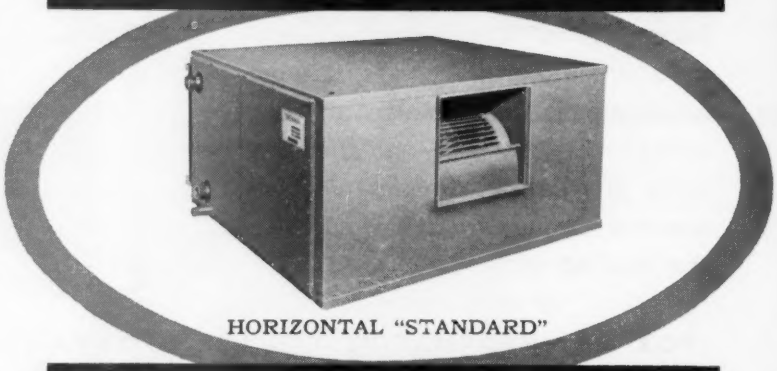
In addition to the EC Air Handling Units, the Thermal Line includes central plant and multizone conditioners, sprayed coil units, heating and ventilating units, heating and cooling coils and air-cooled condensers. Here is air conditioning and ventilating equipment to *specify with confidence.*



HORIZONTAL "DE LUXE"



VERTICAL "STANDARD"



HORIZONTAL "STANDARD"

Quality Products Since 1945

THERMAL ENGINEERING CORPORATION

2605 W. DALLAS • P. O. BOX 13254
HOUSTON 19, TEXAS

AGENTS IN PRINCIPAL CITIES

McDONNELL
Flow Switches



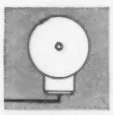
FS4 Series Flow Switch Mounted in a 2 inch Tee

Do you know how many jobs these switches can do?

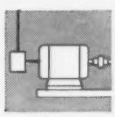
Look at the FS4 Series Flow Switch illustrated here. What you see is a compact, well-built switch that either makes or breaks a circuit (as required) when liquid flows or stops flowing. Yet in this versatile device you have both the most economical way and the most positive way of starting or stopping a signal, an alarm, a motor, a metering device—anything electrically operated. Just to highlight a few uses:—



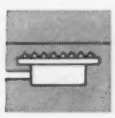
to actuate a signal light—signal an attendant to make the right moves in operating valves, pumps and the like—signal him when flow stops in a water cooled compressor, water cooled bearing and so on.



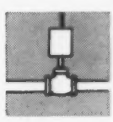
to sound an alarm—when flow stops in a process system or in any water cooled devices.



to start or stop motors—start pumps in sequence in multiple stage flow systems; start standby pumps; stop automatically controlled units if cooling water system fails; stop compressors in cooling systems when flow stops. These are *control* functions, and almost endless.



to start or stop automatic burners—start a booster heater when water draw occurs; stop burner if flow is improperly retarded; make sure of circulation in a boiler before burner is permitted to start.



to actuate metering device—open valve in chemical feeder line; start mixing in secondary line whenever flow starts in primary line.

Think it over! Some of these uses may suggest some related problem the FS4 can solve for you right now. Notice the facts about its construction and service range opposite.

McDONNELL & MILLER, *Inc.*, 3500 N. Spaulding Ave., Chicago 18, Ill.

Doing One Thing Well — SAFETY CONTROLS — REG. U. S. PAT. OFF. — SEE US AT BOOTH 1000

Coupon brings bulletin

It covers design, construction, electrical ratings and dimensions. Points out many typical applications.

Please send me a copy of Flow Switch Bulletin FS1.

COMPANY _____

ADDRESS _____

CITY, ZONE, STATE _____

BY _____

Mail to: McDonnell & Miller, *Inc.*, 3500 N. Spaulding Ave., Chicago 18, Illinois

McDonnell quality throughout:

Compact switch with positive snap action. Removable cover and two knockouts for easy wiring. Phosphor bronze sylphon seals assembly leak-tight from line. Paddle made in segments to fit any pipe from 1" through 3". FS4 series, illustrated, is for maximum working pressure 100 psi; maximum temperature, 300° F., in types as follows:

FS4-3 Single pole, double throw switch. Opens and closes two separate circuits with flow. Closes and opens same two circuits with no flow.

FS4 Closes with flow, opens with no flow.

FS4R Opens with flow, closes with no flow.

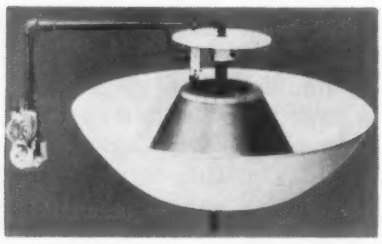
Underwriters' Listed

● Model E-2 available for larger pipe sizes and pressures to 150 psi.

PARTS AND PRODUCTS

OVERHEAD HEATER

Suited for high ceiling industrial and commercial buildings, this infra-red gas heater beams rays down in an even, circular pattern. Silent, clean heat is provided, with no blowers or

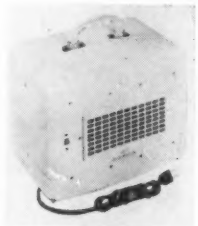


fans to create drafts. Large buildings can have zoned heat where needed, yet leave dead storage areas relatively unheated.

Units operate on either natural or LP gas and are complete with self-energizing thermostats for automatic operation. Infra-red heat emitter is cone-shaped stainless steel, perforated to get maximum heat transfer from hot gases. Rating is 35,100 Btu/hr.
Space-Ray Corporation, P. O. Box 3485, Charlotte, N. C.

AIR PURIFIER

Disadvantages of ozone-producing methods of air purification are cited as being overcome by the Odormaster, which works electrically and chemically to purify and deodorize air. Air is drawn into the unit by a fan and sifted through a washable metal filter, coated with germicide adhesive to trap impurities. Odors are counteracted by non-flammable and non-toxic vapors produced by the purifier.



Portable, the unit is constructed of steel and is equipped with a nine-ft extension cord. When delivered, Odormaster is ready to service areas up to 1000 sq ft for approximately 150 hr.
Aireactor Corporation, 271 Madison Ave., New York 16, N. Y.

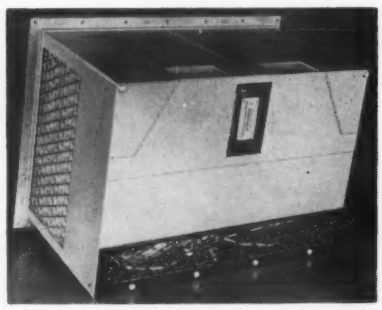
WALL FURNACE

Recently introduced, this 60,000 Btu/hr recessed-type wall furnace includes such features as a "Dualheet" control system permitting low speed blower and burner operation for normal heating requirements and a high speed adjustment for full capacity. Twin blowers, mounted on a single motor, are operated automatically to supply the heat variations.

Other features include an automatic gas valve, coated heat exchanger, top rear vent connection and a glass-sealed magnetic room thermostat.
Payne Company, 855 Anaheim-Puente Rd., La Puente, Calif.

1½-TON CONDITIONER

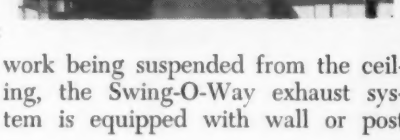
Designed specifically for weapon support equipment, this 1½-ton lightweight air conditioner occupies less than four cu ft. Rotating elements operate in the industrial speed zone of 3400 to 3700 rpm for both compressor and fans. Use of low speed components is cited as having resulted in low audible noise level, simple maintenance and reliability.



Newest in the line, this unit is offered in 60 and 400 cps models, both containing the same basic parts. Specifications include operation to 125 F ambient air, 600 cfm conditioned air flow and 5.4 kw power consumption under peak operating conditions.
Task Corporation, 1009 E. Vermont Ave., Anaheim, Calif.

EXHAUST SYSTEM

Suited for use where traveling overhead cranes will not permit duct



work being suspended from the ceiling, the Swing-O-Way exhaust system is equipped with wall or post mountings permitting 180 deg swing range. Retractable flexible hose allows for an extension up to 30 ft from the blower, with heavy rigid construction for service with a powerful high speed blower.
Ammerman Company, Inc., S. Greeley St., Stillwater, Minn.

CLOGGED FILTER SIGNAL

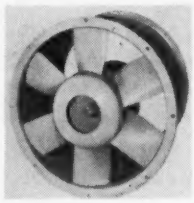
For use with forced air furnaces, air conditioners or heat pump units, this clogged air filter warning device has been introduced in a flush-mounted model. Designated Filter Flag, the signal can be used with special thermostat subbases to provide a red warning light when the filter needs attention or with a Weather Station year-round air conditioning control panel. Also available in both surface and flush-mounted models is a special warning signal for use with central air conditioning units. Whenever the filter becomes clogged, the cooling unit is shut off automatically to prevent possible coil "freeze up."



Minneapolis-Honeywell Regulator Company, 2753 Fourth Ave. S., Minneapolis 8, Minn.

AXIAL FLOW FANS

Direct and belt-driven axial flow fans for general ventilation, dust and fume removal and similar services have been introduced by this manufacturer. Features include airfoil fan wheels, flanged heavy-gauge fan casings, sealed prelubricated self-aligning bearings and improved capacity per hp. Capacities at zero static pressure range from 3220 to 72,500 cfm. An extensive choice of motor types is available, and options include aluminum fan wheels, anti-corrosion materials and protective coatings, inlet and outlet cones and adjustable sheaves for the belt-driven units.



L. J. Wing Manufacturing Company, Linden, N. J.

BLOWER SYSTEMS

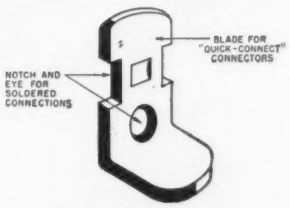
Development of new and improved dual blower systems for blower-type gas-fired unit heaters and modular duct furnaces has been announced.

A FEW FACTS ABOUT MOTOR CAPACITOR TERMINALS

Contrary to a common belief shared by many users of specialty capacitors for a-c applications, all capacitors are *not* alike. Some brands have not changed in design or construction for years. Others make changes to keep up with competitive products. Sprague Electric, however, constantly improves its designs for maximum dependability and minimum cost,.

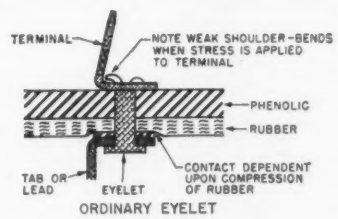
Although the terminal assembly is a relatively small part of the entire unit, it has often been the cause of capacitor failure. Here, Sprague has developed new, improved terminals which eliminate failures of this nature, reduce equipment manufacturers' assembly time, and make future servicing easier. Here are some of those recent improvements:

1. "UNIVERSAL" TERMINAL LUG

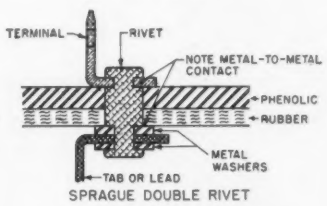


Single-blade or dual-blade, designed for use with "quick-connect" connectors. Also has notches and eyes for soldered connections—an important feature when "quick-connect" connectors are inadvertently destroyed by servicemen. Copied and imitated by others, universal terminal was originally designed by Sprague, is now patented by Sprague.

2. DOUBLE RIVET CONNECTION



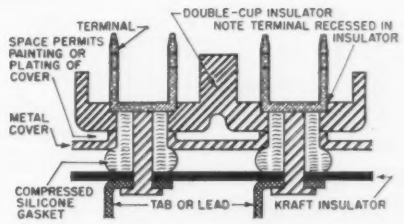
ORDINARY EYELET



SPRAGUE DOUBLE RIVET

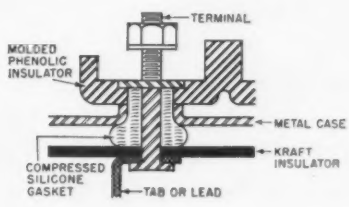
Unique new rivet design for positive metal-to-metal contact between rivet and terminal as well as between rivet and tab. Unlike ordinary eyelet where weak riveted shoulder will bend or break when terminal is pulled, as often happens when removing snug-fitting "quick-connect" connectors, Sprague rivet prevents arcing caused by loosened contact points. Patent pending on this unique design.

3. DOUBLE-CUP INSULATOR



New one-piece molded phenolic cups for increased rigidity and prevention of terminal rotation. Unlike ordinary single-cup construction, which permits accidental twisting of terminals, causing leads inside capacitor to "short" or break off, terminals in Sprague's new double-cup insulator cannot turn because of square recess in molding which accommodates base of terminal. Bottom of insulator has contoured shape which permits plating or painting of entire capacitor cover, in full compliance with Underwriters' Laboratories, Inc. requirements for outdoor applications. No hidden, unprotected areas, as with ordinary single-cup. Patent pending on this assembly.

4. STURDY STUD TERMINAL



Pull-proof, welded terminal assembly designed to take severe physical abuse. The first reliable stud terminal available on a-c specialty capacitors. Although superior in performance, new Sprague design actually costs less than any other stud-type terminal. Patent pending on this assembly.

For Engineering Bulletins or application assistance on Sprague's complete line of a-c specialty capacitors, write to Technical Literature Section, Sprague Electric Company, 383 Marshall Street, North Adams, Massachusetts.

WORLD'S LARGEST MANUFACTURER OF CAPACITORS

SPRAGUE®
THE MARK OF RELIABILITY

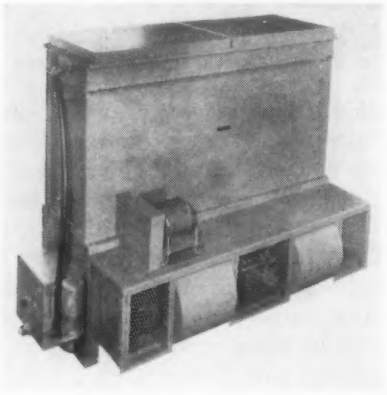
Used with 250,000 and 300,000-Btu/hr US Series heaters and with DSB Series packaged blower systems for the same capacity furnaces, the systems are powered by a single ½-hp motor, with blowers mounted on a common drive shaft. Two 1/3-hp motors were used formerly to drive the blowers, which were mounted previously on individual shafts.

Utilization of a single motor not only reduces hp requirement of the system, but also simplifies its electrical wiring and lowers operating and maintenance costs. A single drive shaft assures smooth, even inlet air flow, improving efficiency of the blower system.

Reznor Manufacturing Company, Mercer, Pa.

EVAPORATIVE CONDENSERS

Furnished with a base capacity range of 15 to 300 ton, this new line of

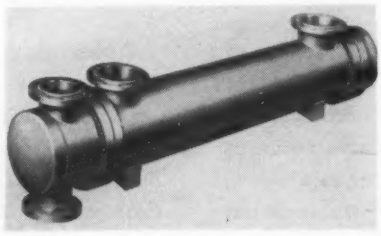


centrifugal fan, blow-through type evaporative condensers features easy access to float valve and strainer, which are contained in an external sump box. Condensers are designed with free-draining V-bottom sump and heavy gauge hot-dip galvanized casings, full weight ¾-in. steel pipe condensing coil and all-welded sump tank hot-dip galvanized after fabrication. Units are for use with either halogenated hydrocarbon or ammonia refrigerants.

Forseille Products, Inc., P. O. Box 6755, Baltimore 4, Md.

HEAT EXCHANGERS

Built from standard, pre-engineered components assembled into custom-built units for specific chemical and industrial processing requirements, the C-200 line of straight-tube, fixed tube-sheet heat exchangers is now available. For use as heaters, coolers, condensers or vaporizers, the units will handle any combination of liquids and gases and are available in shell sizes from 8 through 42 in. Shell-side and tubeside design pressures range from 75 to 300 psi with design temperatures for both rated at 400 F. Design temperatures up to 650 F on shell and tubesides are permissible



with carbon steel construction, depending on operating conditions.

Tubeside materials are available in Types 304 or 316 stainless steel, cast iron, brass or carbon steel to accommodate a wide variety of fluid chemical properties. Tubesheets are also available in rolled naval brass-clad steel.

American Radiator & Standard Sanitary Corporation, Industrial Div, Detroit 32, Mich.

PORTABLE VOLTMETER

Making a continuous record of the actual voltage supplied by a 115 or 230-volt ac power source, this portable, miniaturized recording voltmeter covers ranges of 70 to 135 and 140 to 270 volt.



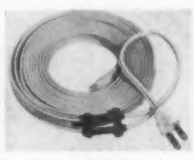
Recording is continuous for 31 days and is on a specially prepared paper, using a smudge-proof dry-marking process.

Rapid response to voltage changes is achieved by a free-swinging needle that contacts the paper momentarily every two sec. A synchronous motor-driven mechanism assures exact timing.

Airserco Manufacturing Company, 435 Melwood Ave., Pittsburgh 13, Pa.

HEATING BANDS

Electric heating bands for providing supplementary heat to the drain tubes of low temperature cooler coils have been introduced in lengths of from 3 to 100 ft for 110 volt and 6 to 200 ft for 220 volt. Each dissipates 7 watt/ft.

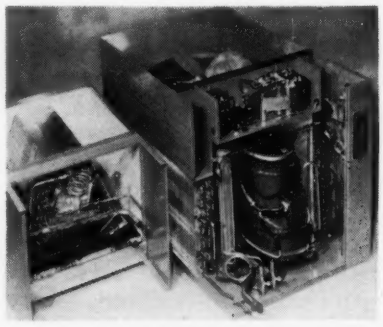


Waterproof and of molded vinyl, the bands hold pre-spaced heater wire safely in place in separate channels. All connections and ends are sealed hermetically, and the unit is attached to a cold lead wire and molded plug.

Easy-Heat, Inc., Lakeville, Ind.

REMOTE CONDITIONER

Designated Champion, this remote air conditioner is available in either a two (CA-24) or three-ton (CA-36) model. Both use the same size outside cabinet. Low-silhouette vertical-air flow outside section has a low sound level and is painted with baked enamel both inside and out for protection of the zinc grip-coated steel casing. An extensive line of upflow, horizontal duct and counterflow coils with insulated cabinets is available,



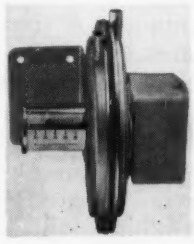
with blower sections, decorative plenums and combination heating and cooling thermostats.

Shown are the works of the units, which have compressors with external spring mounts and crankcase heaters, high and low pressure controls, service valves, improved wiring harness, receiver and aluminum fan blades. Upflow evaporator coil, at left, is for furnace or vertical duct installation. Coils are available also for horizontal duct or counterflow installation.

York Div, Borg-Warner Corporation, York, Pa.

PRESSURE SWITCH

Suitable for such applications as liquid level controls, induced draft interlocks, exhaust hoods, dust collection systems and air filters, this differential pressure switch is designed for control in pressure ranges too low for conventional switches. One model of the Series 1630

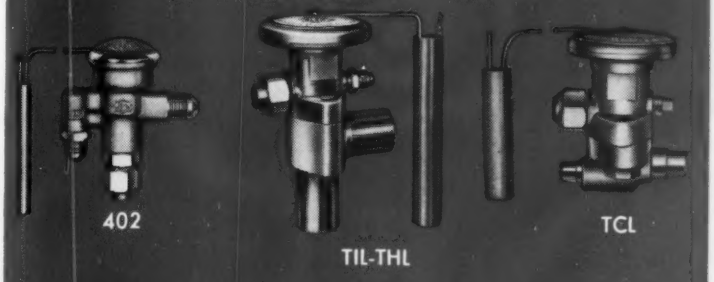


switches may be set to open a circuit on a pressure differential increase of only 0.05 in. water and to close on a decrease of 0.03 in. Repetitive accuracy is within 1%.

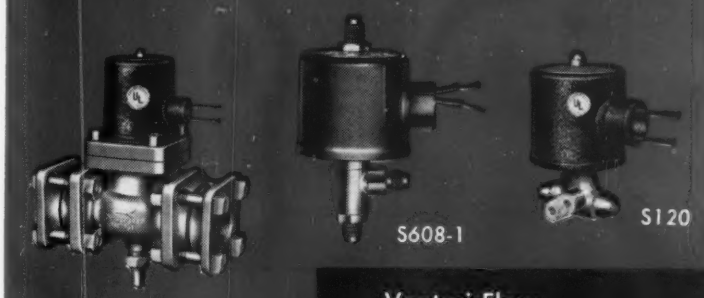
Pressure set point of the instrument is easily visible on a scale marked in

ALCO *the one complete line of* REFRIGERANT CONTROLS

Thermo® EXPANSION VALVES
for all refrigerants from 1/4 to 200 tons



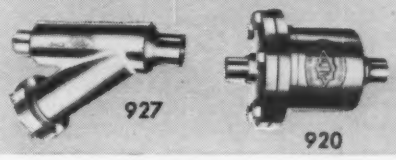
SOLENOID VALVES
Sizes & Type for every application and refrigerant



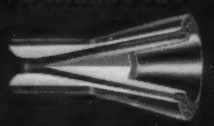
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ALCO VALVES • CONTROLS STRAINERS • DISTRIBUTORS
FOR EVERY APPLICATION—DIRECT EXPANSION OR FLOODED SYSTEMS

REFRIGERANT STRAINERS
maximum Screen area—
Sizes & Type for every application



Venturi-Flow DISTRIBUTORS

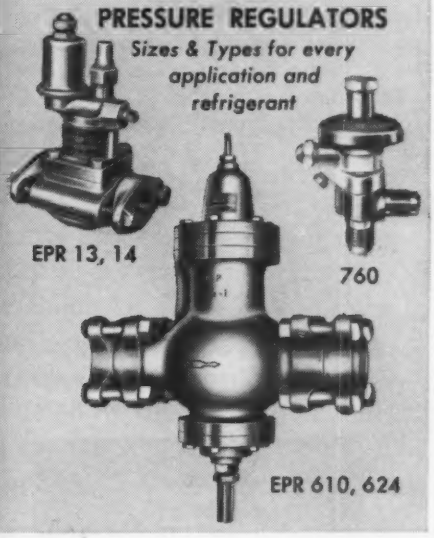


wide application . . . low pressure drop . . . any position . . . one-piece construction . . . no nozzles



Float SWITCHES
for trouble free liquid level control

EVAPORATOR PRESSURE REGULATORS
Sizes & Types for every application and refrigerant

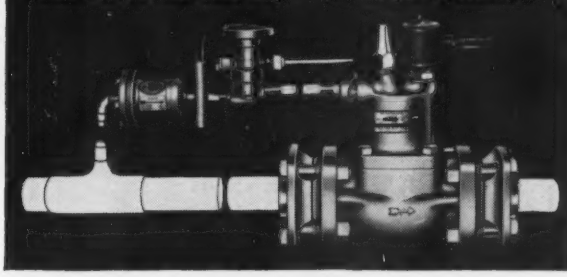


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97% pure Dessicant
Block Form
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P.O.S. PILOT OPERATED THERMO® VALVE
with integral solenoid stop . . . for larger installations



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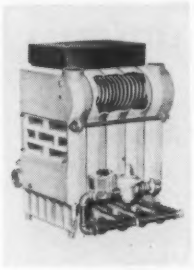
The one complete line of refrigerant controls: Thermostatic Expansion Valves • Refrigerant Distributors • Solenoid Valves Refrigerant Filter-Driers • Suction Line Regulators • Flooded Evaporator Controls and Reversing Valves

8217-2

in. of water. Calibration adjustments may be sealed or safety wired, making the switch tamper-proof. Switches incorporating explosion-proof or weather-proof housings, special diaphragms for extremely low temperatures or fail-safe pilot lights are available also.
F. W. Dwyer Manufacturing Company, P. O. Box 373, Michigan City, Ind.

COMPACT BOILERS

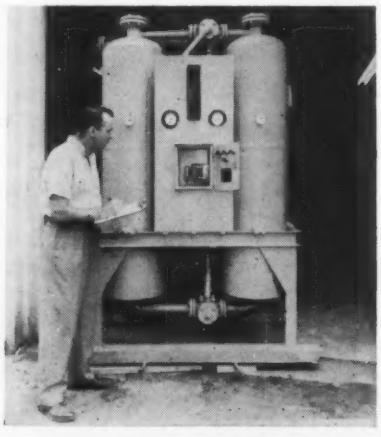
Ranging from 90,000 to 360,000 Btu/hr input, a compact line of gas-fired, cast iron boilers has been introduced. Designated Series 60, eight model sizes for water or steam are available in standard assembly models with factory packages in three sizes.



High offset cast iron water tube construction establishes a predetermined height of boiler for all models regardless of size. Jacket and boiler have clean-out doors enabling easy cleaning without removing the jacket. Burners are cast iron with one-unit slotted port design incorporating venturi and burner in a single casting for quiet operation. Heavy layers of glass wool insulate the entire boiler for maximum heat retention. Additionally featured is a tankless water coil for supplying domestic water, summer and winter.
Peerless Heater Company, Boyertown, Penna.

GAS DEHYDRATOR

Providing continuous moisture removal, the Dehyditrol is self-contained for dehydration of compressed air and other gases. Units are versatile for application to any operation where elimination of moisture is a prime consideration.



Continuous moisture removal feature of the units uses twin chambers, each charged with a fixed bed of desiccant. While one chamber is being used for drying, the saturated desiccant in the other is being reactivated. The process then is reversed automatically.

Change of direction of the gas, to reverse the roles of the chambers, is accomplished by a quarter turn of four-way lubricated plug valves. By putting two different sets of ports in contact, flow through the entire machine is reversed.
Gas Drying, Inc., P. O. Box 56, Summit, N. J.

FLOW MONITOR

Operated on the principle of the Thermopile, this flow monitor is compensated fully for changes in temperature and rate of change of temperature. An electrical output suitable for remote indication, control or recording of mass flow rates is available.

A center reading flowmeter, the instrument features variable sensitivity and range, being adjustable for a wide range of flows at midscale by means of interchangeable flow tubes and control adjustments. For example, with the K-23 flow tube of ⅜-in. diam, the range at midscale can be varied to read as little as 90 standard cc/min or as high as 40,000 standard cc/min (0.003 to 1.4 cfm). Operation is from 90 to 135 volt ac, 60 cycle, and the unit may be panel-mounted or used in the cabinet as shown.



Hastings-Raydist, Inc., Hampton, Va.

REMOTE READING SENSOR

Portable, wide span, multi-range and transistorized, YSI Model 42 Tele-Thermometer is a battery-powered, remote reading, continuous indication thermistor thermometer. Ranges covered by the instrument are −40 to 150 C and −40 to 300 F, in two models, each having three overlapping ranges. Utilized is a transistor-controlled constant current Wheatstone Bridge to allow monitoring of a wide range to an accuracy of ±0.5 C or ±1 F in conjunction with thermistor probes. Multiple range gives readabilities of ±0.2 C or ±0.25 F over an extensive range.



Model 42 can be used with any YSI 400 series interchangeable probe for direct, remote, continuous indication of temperatures in humans or animals, chemical processes, liquids, surfaces and many other areas.
Yellow Springs Instrument Company, Inc., Yellow Springs, Ohio.

FLEXIBLE COUPLINGS

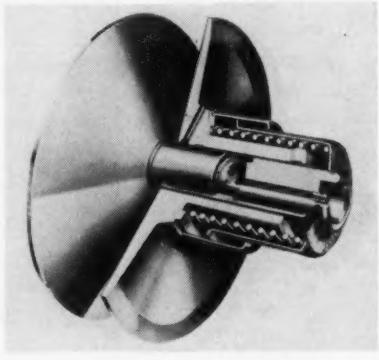
Incorporated into Spira-Pipe air distribution lines, Ventiduct flexible couplings are cited as outmoding bolted flanges and welded or riveted methods of joining sheet metal ducts. An airtight duct connection is provided, and assembly and disassembly can be accomplished in less time than required previously.



Aeroquip Corporation, Marman Div, 11214 Exposition Blvd., Los Angeles 64, Calif.

PULLEY DRIVES

Variable speed motor pulley drives, designed for economical operation, are now available in ratings of from one through fifteen hp. Output speeds range from 141 to 2200 rpm with a three-to-one speed variation utilizing 1160 or 1750-rpm motors.

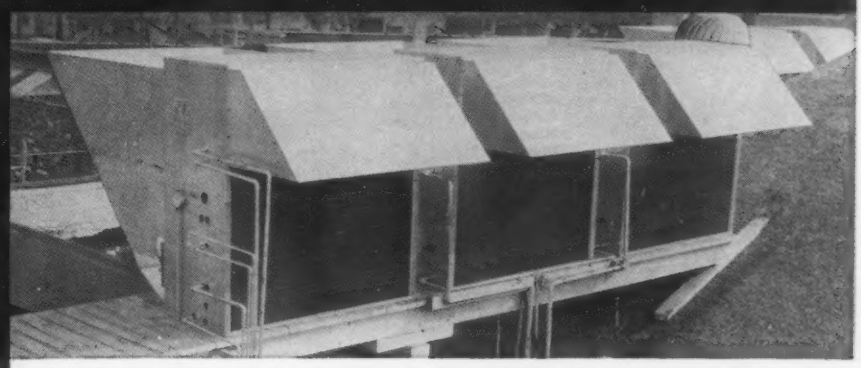


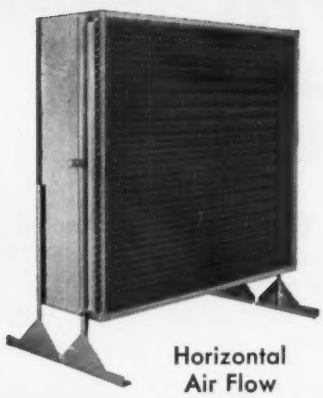
Incorporating the power transmission of a V to V drive and a simple motor pulley design, these units provide reliable power transmission combined with max hp capacity. Applications include utilization with centrifugal pumps, presses and many other types of equipment.
Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.



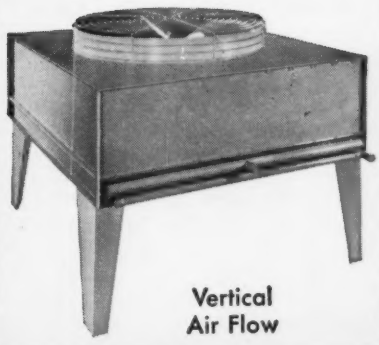
BOHN

AIR COOLED CONDENSERS END WATER PROBLEMS!





Horizontal Air Flow



Vertical Air Flow

Sacramento Supermarket Saves $200 a Month in Water and Sewerage Bills Alone!

Water in Sacramento, California is hard and it's costly! Arata Brothers Supermarket solved this problem by changing from water cooled condensers to 7 Bohn Air Cooled Condensers. The result was lower maintenance and lower operating costs ... with savings of $200 monthly on sewerage and water bills alone. More importantly, the Bohn Air Cooled Condensers maintain even temperatures in the store's refrigerated equipment *at all times of the year!* Even a high temperature of 114° recorded in 1959 was easily handled by the Bohn Air Cooled Condensers! Whether it's hot or cold, Bohn controls adjust automatically to seasonal weather changes and maintain proper head pressure at all times.

For low first cost... low operating and maintenance costs, the answer is Bohn Air Cooled Condensers... available in horizontal models (deflectors optional) and in low-silhouette vertical models.

2 through 60-ton sizes.

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FIFTEENTH INTERNATIONAL HEATING AIR-CONDITIONING EXPOSITION

BOHN *Buy the known line... the BOHN line*

ALUMINUM & BRASS CORPORATION

Danville Division • Danville, Illinois

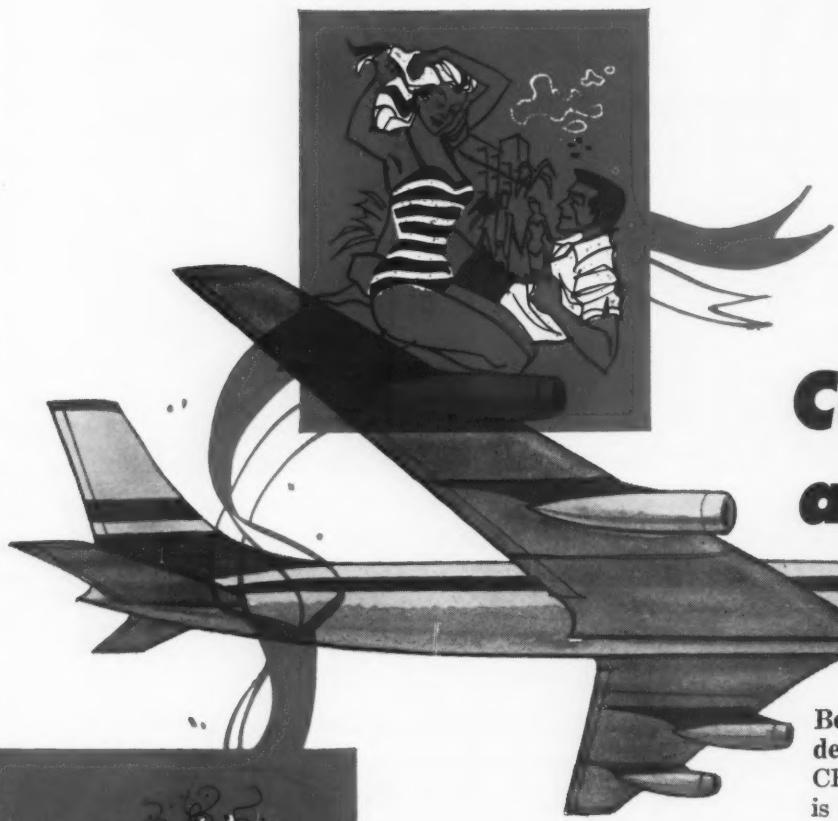
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Cooling Towers and DriCoolers







Best In Cooling Towers and Air Cooled Condensers . . . AND A BONUS FOR CUSTOMER CERTIFICATION OF SATISFACTION. This is Marley's method of building better customers through better understanding of cooling equipment by owners.

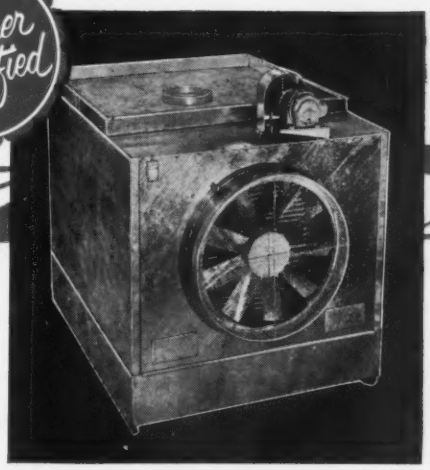
Join this owner-education program and you can be selected to receive an all-expense-paid vacation for two. Every contractor is eligible; all you do is send the names—Marley does the rest. One of these holiday tours (plus cash for entertainment) may be yours:

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Get complete information immediately from your Marley Man or send in the coupon on next page; an early start gives you a bigger opportunity.

Full information at Marley Booth No. 616 ASHRAE EXHIBIT Chicago, Feb. 13-16

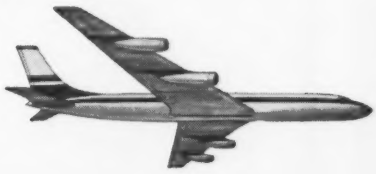
THE MARLEY COMPANY



AQUATOWERS® Superior performance, rugged construction and hot dip galvanizing for long-service durability make them the world's most-preferred steel mechanical draft cooling towers. Operational dependability eliminates profit-reducing service call-backs, making Aquatowers tops in over-all economy — first in customer satisfaction.



PERMATOWERS® These towers bring together Marley's performance-proved Double-Flow design and a selection of unique construction materials—a combination which results in a high-performance tower with maximum resistance to corrosive elements. Vertical air discharge permits location in closely confined locations.

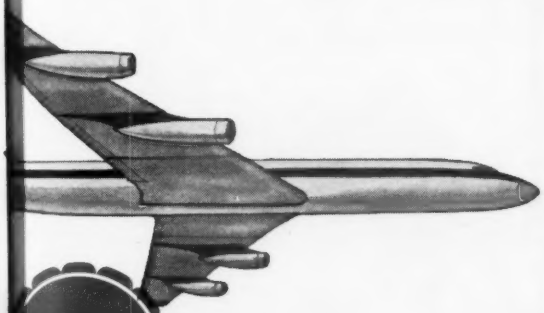


JUST SEND THE NAMES OF CUSTOMERS

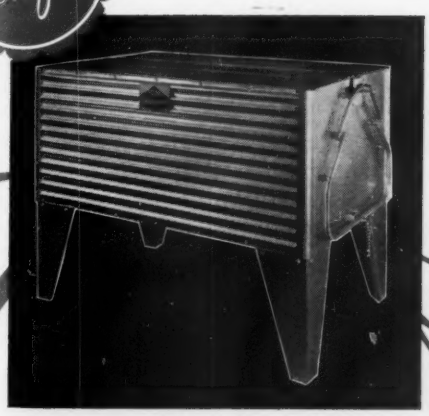
Who have purchased Cooling Towers or DriCoolers since February 1, 1961 — **that's all**

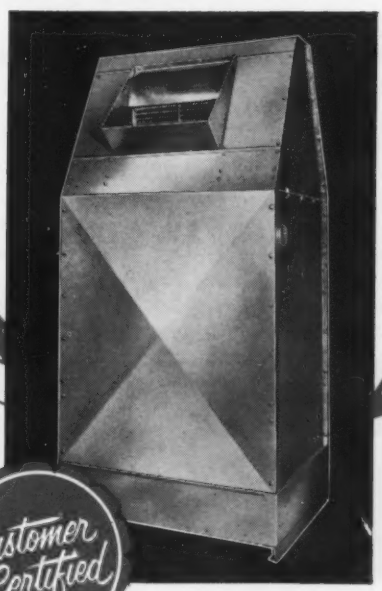


SPRATOWERS® Ruggedly constructed natural draft towers offer maximum water cooling economy both in original investment and operating cost. Design of nozzles and spray system assures efficient water cooling performance with minimum maintenance. All tower components are piece-marked for quick, easy assembly.



AQUACOOLERS® Whisper-quiet, leak-proof operation makes AquaCoolers especially suited for indoor installation. Air delivery adjustable to accommodate ductwork pressures. Minimum assembly requirements permit quick, easy installation. All models hot dip galvanized for long service-life.





DRICOOLERS® Air cooled refrigerant condensers engineered for durability, controllability, compatibility. Efficient blow-through design adaptable to any location. Damper control for fool-proof, low-temperature operation of single- or multi-circuit units. Exclusive PreCooler overcomes high dry bulb temperatures.

THE MARLEY COMPANY
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Send me immediately information on your "Customer Certified" program that offers bonuses for owner education.

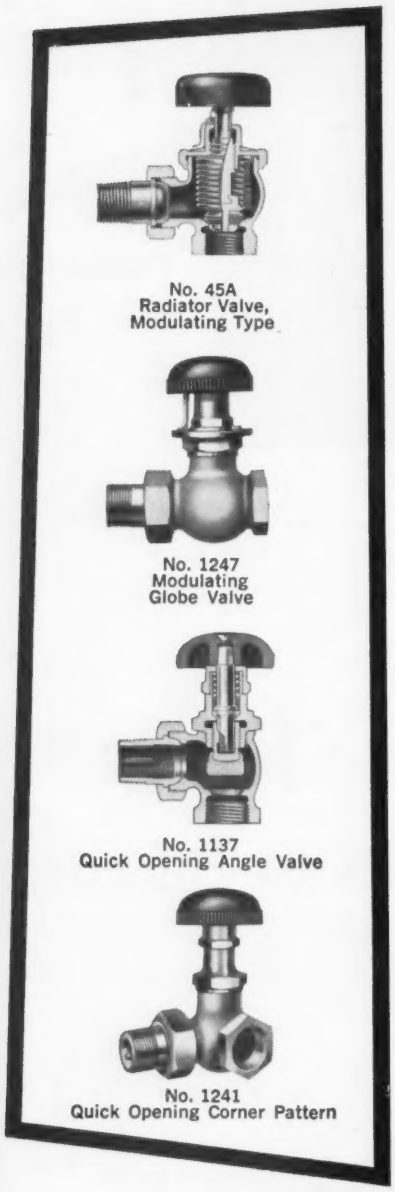
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You can meet your most exacting needs in radiator valves with Sarco. For steam: Bellows-Packless, Spring-Packless, and Gland-Packed. For hot water: Spring-Packless and Gland-Packed. Made in globe and gate types, angle and corner patterns, modulating and quick opening. Sizes from ⅜" to 2", pressures up to 200 psi.

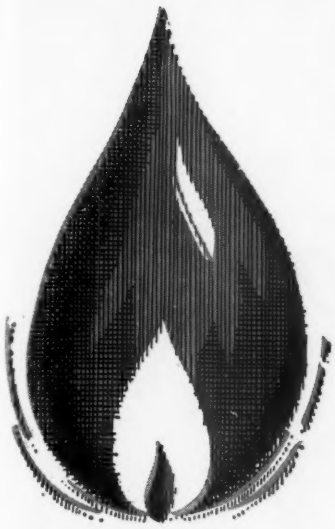
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of the new Bulletin No. 225, covering radiator valves, balancing fittings, and access boxes, with sizes, capacities, and roughing-in dimensions.



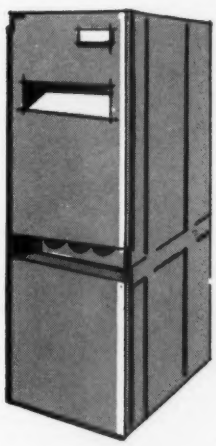
SARCO

SARCO COMPANY, INC.
AN AFFILIATE OF SARCOTHERM CONTROLS, INC.
635 MADISON AVENUE, NEW YORK 22, N.Y.
PLANT: BETHLEHEM, PA.

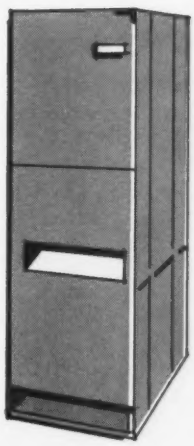


GM Delco ANNOUNCES A HOT NEW GAS LINE

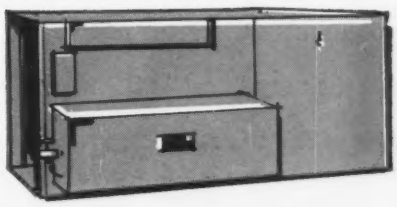
GM-DELCO engineers have designed a complete new line of gas-fired Conditionair furnaces for 1961. This new GM-DELCO line includes the refinements that dealers and builders want most. It's designed to accept air conditioning for complete central heating and cooling. Handsome, durable, efficient and compact units—easily installed. Brand name acceptance makes the new 1961 GM-DELCO line easier to sell.



NEW 1961 GM-DELCO HIGHBOY. Available now in 70, 80, 100 and 125,000 BTU input capacity. Other models up to 190,000 BTU input are available. Easily installed in closet or corner locations with zero clearances, low enough for basement installations.



NEW 1961 GM-DELCO COUNTERFLOW MODEL. Here's a convincing answer to dependable, low-cost installations. Ideal for perimeter systems in crawl space or slab homes. Durable cast iron slotted burners and super-quiet blowers are featured throughout the new 1961 line.



NEW 1961 GM-DELCO HORIZONTAL GAS FURNACE. Designed for installation in utility rooms, attic areas, crawl space and suspended applications. Models run from 60,000 to 140,000 BTU input. Tested and approved by the American Gas Assn. for use with natural, manufactured, mixed and L.P. gases.

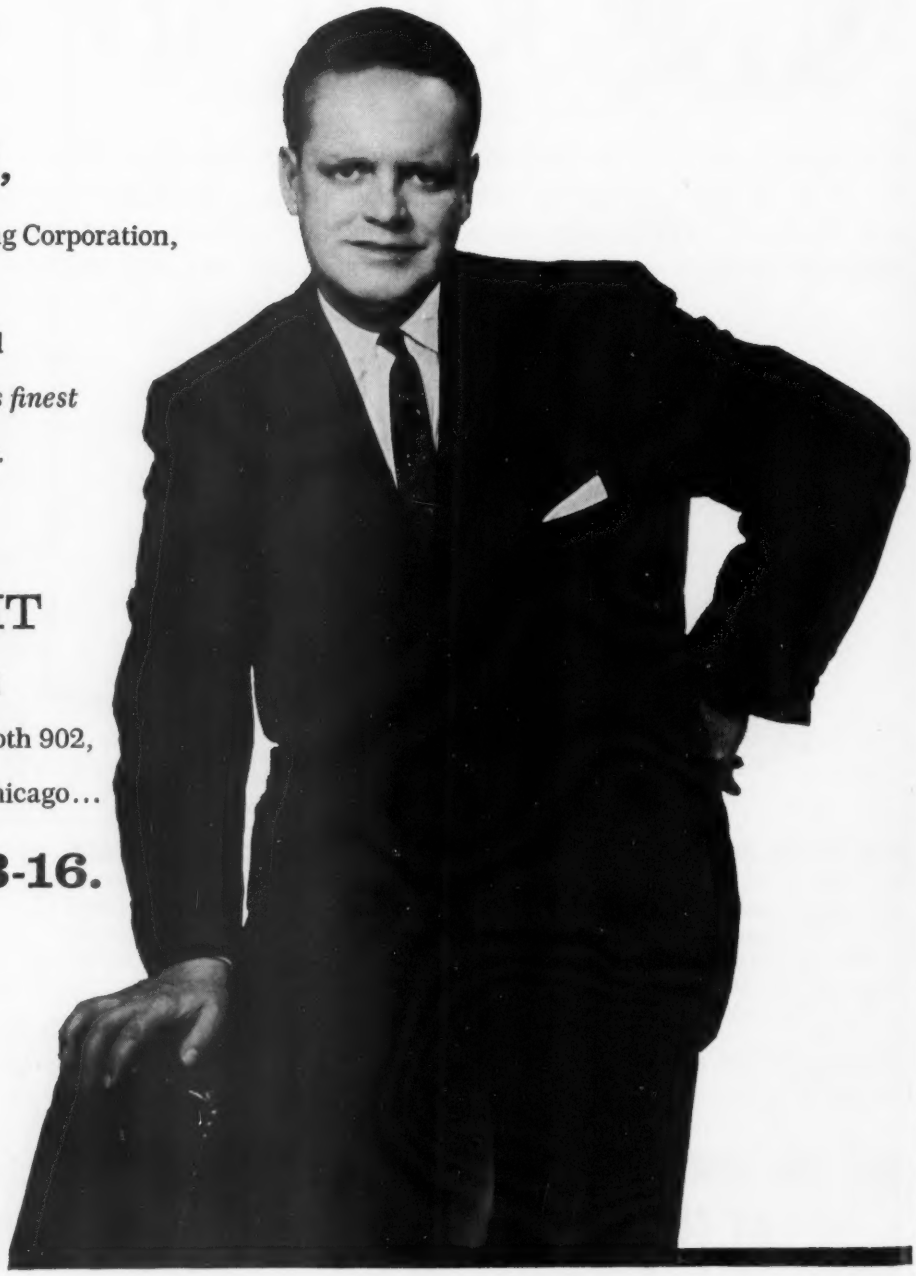
THE NEW 1961 GM-DELCO LINE is handsomely and durably finished in Sahara Tan and Cameo Beige and features the sheer modern lines which lend fine appearance and make installation in limited space possible. The entire line has been engineered to accept the Delco air conditioning units that are part of GM-Delco 365 Conditionair systems.

Whatever the type of home, whether traditional or modern, full, half or no basement, one or two story, split-level—there are GM-DELCO heating or air conditioning systems engineered to the highest reliability standards to meet all your requirements.

SEE THE COMPLETE NEW DELCO LINE OF GAS FURNACES AND AIR-CONDITIONERS AT GENERAL MOTORS-DELCO DISPLAY SPACE N330 AND N332

GM Delco 365 CONDITIONAIR

An Invitation



DON TITUS,

president of Titus Manufacturing Corporation,
cordially invites
you to meet the Titus people and
see the very latest in the nation's finest
line of Air Distribution Products.

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at the International Heating and
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FEBRUARY 13-16.

TITUS Manufacturing Corporation
- WATERLOO, IOWA
- Hialeah, Florida
- Terrell, Texas

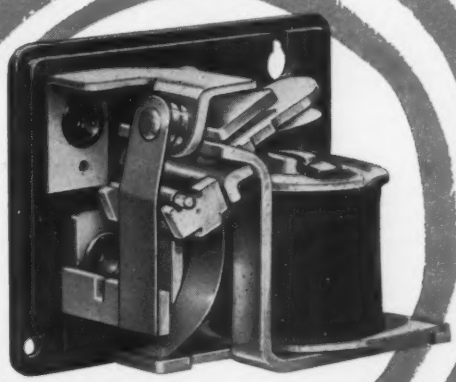


Photo Actual Size

where high starting torque is essential

RANCO H80 VOLTAGE STARTING RELAYS on capacitor-start motors up to 5 hp., provide high starting torque for low temperature systems, commercial refrigeration, air conditioning units, and heat pump systems. Relay contacts open and close by variation of the magnitude of the voltage applied to the relay coil. At the instant of starting the motor, the normally closed relay contacts stay closed until the motor builds up speed and the start-winding voltage increases. Special air-gap construction eliminates the problem of "residual magnetism" between armature and core after the relay is de-energized. Relay coil and contacts withstand switching of high transient voltages. High contact pressure prevents relay contact from bouncing and sticking. And the rugged construction of the Ranco H80 provides remarkable resistance to shock and rough handling. Write for further information and Technical Bulletin 1806.

RANCO CONTROLS

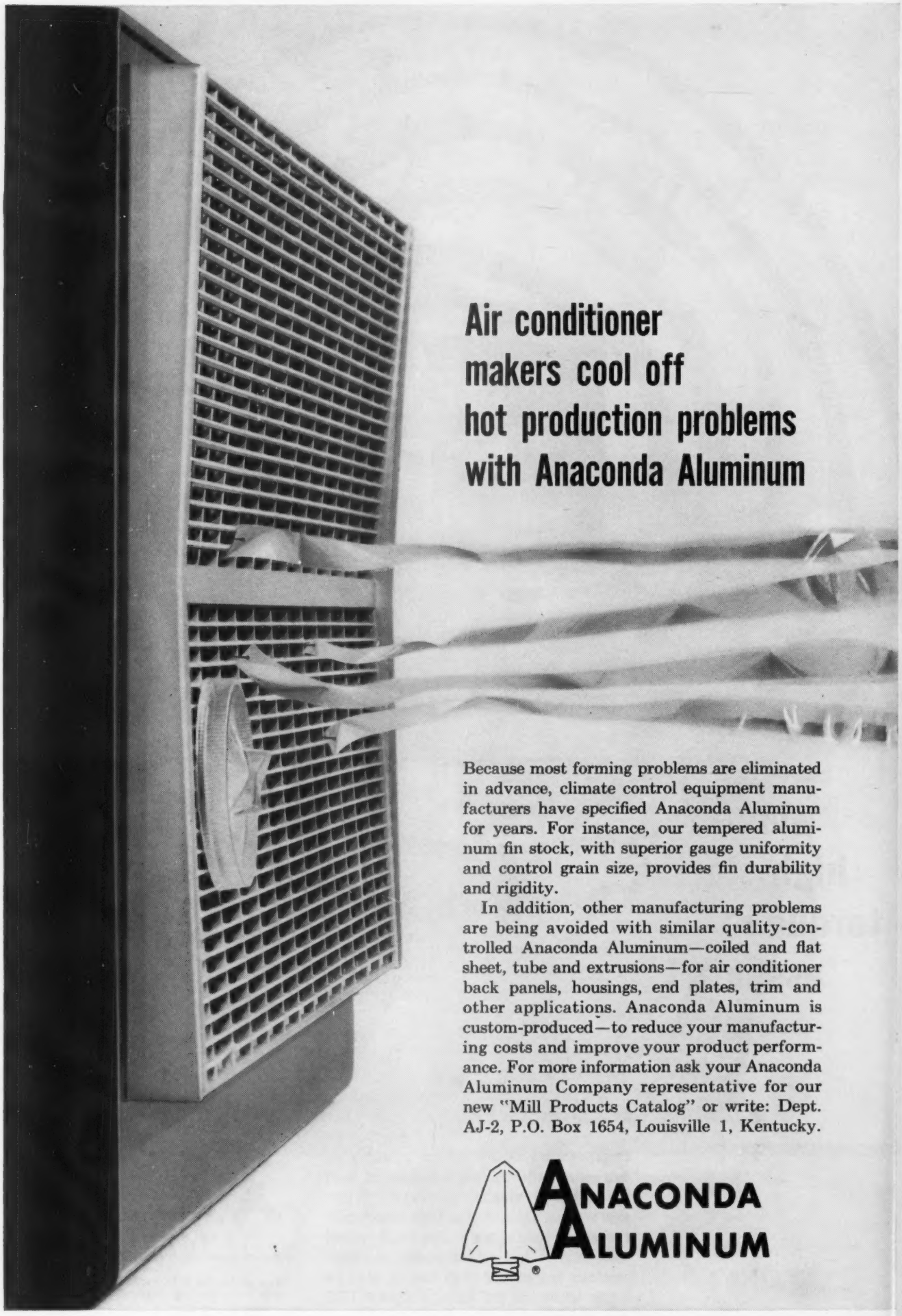
Ranco®

INCORPORATED

COLUMBUS 1, OHIO

In Canada: Ranco Controls, Canada, Ltd., Toronto 18, Ontario

See us at the International Heating and Air Conditioning Exposition Booth 855



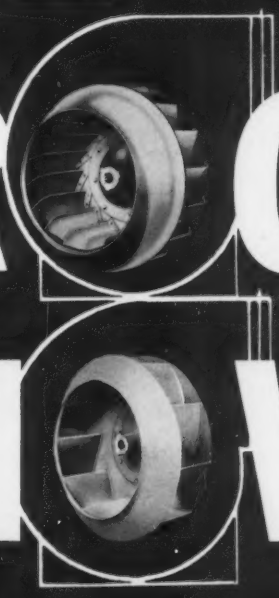
Air conditioner makers cool off hot production problems with Anaconda Aluminum

Because most forming problems are eliminated in advance, climate control equipment manufacturers have specified Anaconda Aluminum for years. For instance, our tempered aluminum fin stock, with superior gauge uniformity and control grain size, provides fin durability and rigidity.

In addition, other manufacturing problems are being avoided with similar quality-controlled Anaconda Aluminum—coiled and flat sheet, tube and extrusions—for air conditioner back panels, housings, end plates, trim and other applications. Anaconda Aluminum is custom-produced—to reduce your manufacturing costs and improve your product performance. For more information ask your Anaconda Aluminum Company representative for our new "Mill Products Catalog" or write: Dept. AJ-2, P.O. Box 1654, Louisville 1, Kentucky.

ANACONDA ALUMINUM

SEE PROGRESS AT THE SHOW

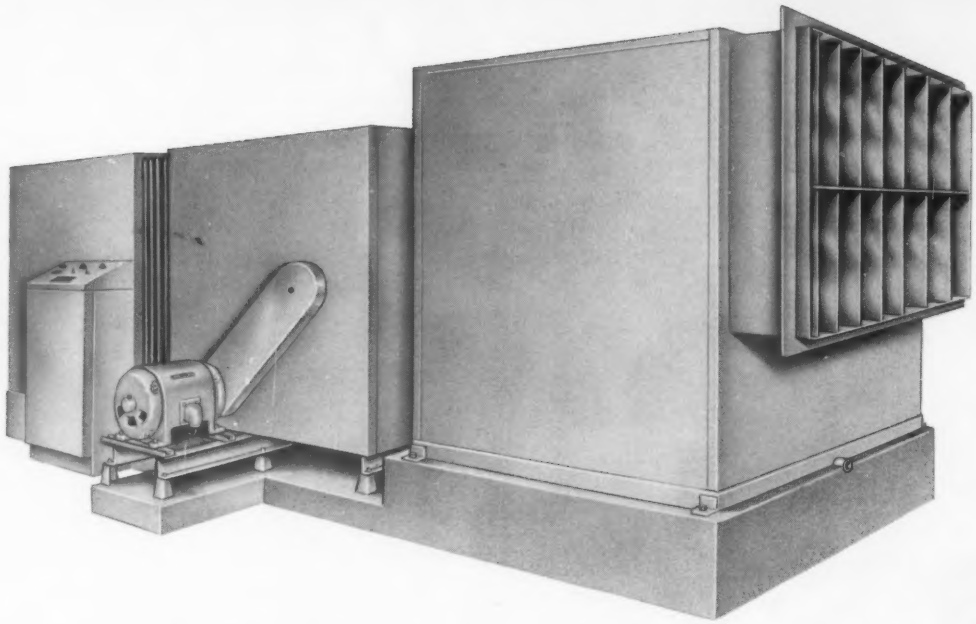


by 'BUFFALO'

THE 'BUFFALO' TYPE BL FAN... made famous by the exclusive backward-curved bladed wheel. Proven performance for Class I and II construction applications. Stationary vanes standard. Optional variable inlet vanes give efficiencies within 1% of rating. You cannot buy a better fan for the job at any price! Learn more about this popular fan at the 'Buffalo' Booth. See where it fits in your plans!

THE 'BUFFALO' AIRFOIL FAN... modern answer to higher pressure jobs where efficiency must be kept at a maximum; noise at a minimum. Here's an airfoil that gives high efficiency over a broad operating range. Famous 'Buffalo' quality construction, too. Are you encountering more jobs where you must have such a fan? Here is your chance to see the latest in airfoils "first hand"; find out about all the outstanding design features.

BOOTH 832-933 ASHRAE SHOW—CHICAGO



'BUFFALO' TYPE "PCHB" HIGH PRESSURE CABINETS...a new design incorporating the high quality 'Buffalo' type "BL" fan. Other unique features include: individual factory-sized zone dampers, horizontal or vertical up discharge; neoprene flexible connection between fan and coil sections, angled coils for minimum space requirements, with typical 'Buffalo' quality construction throughout. The unit at the show will also incorporate an Electronic Air Cleaner. Sound interesting? You bet it is. Here's a unit you will want to see close-up!

BUFFALO FORGE COMPANY

THE 'BUFFALO' AIR COOLED CONDENSER... a recent design typical of 'Buffalo' superiority in "package" unit engineering and construction. A really low silhouette. Multiple fans for versatility. Unique opposed blade by-pass damper control for ultra-accurate performance. Rugged frame construction. This unit is shipped complete, ready to install. Many of these condensers are in the field giving unparalleled performance. Be sure not to miss this one! Next time you need an air cooled condenser, you'll be glad you took the time to learn about all the exclusive features of this 'Buffalo' unit.



BUFFALO, NEW YORK

"Buffalo"

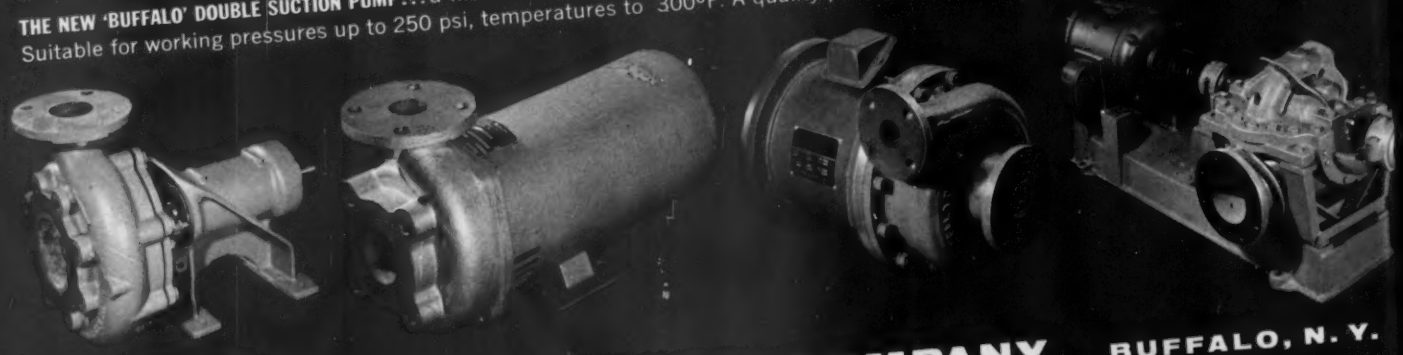
BUFFALO PUMPS AT THE EXPOSITION

THE NEW 'BUFFALO' ECONOMY SINGLE SUCTION PUMP... features in addition to a low price, full ball bearing construction, open type mounting and discharge position rotation. Parts are standardized and interchangeable. Rotor assembly removable without disturbing piping.

THE NEW 'BUFFALO' CLOSE-COUPLED PUMP... a low cost compact package unit with a wide range of fresh water applications in industrial and air conditioning service. Standardized for parts interchangeability. Ball bearing design with mechanical seal; stainless shaft.

THE NEW 'BUFFALO' HERMETIC PUMP... a new design with wear compensating type bearings to take thrust loadings. Wide range of materials of construction. Pressures up to 400 psi. This is the pump to use where leakage would be costly or dangerous.

THE NEW 'BUFFALO' DOUBLE SUCTION PUMP... a modern, high efficiency design featuring standardization of parts for interchangeability. Suitable for working pressures up to 250 psi, temperatures to 300°F. A quality pump built for years of trouble-free service.



"Buffalo"

BUFFALO FORGE COMPANY BUFFALO, N. Y.

BUFFALO PUMPS DIVISION

Canadian Blower and Forge Co., Ltd., Kitchener, Ont. • Canada Pumps, Ltd., Kitchener, Ont.



'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.



'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.



'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.



Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

WHY YOU SHOULD SPECIFY

Phelps Dodge Copper Refrigeration Tube

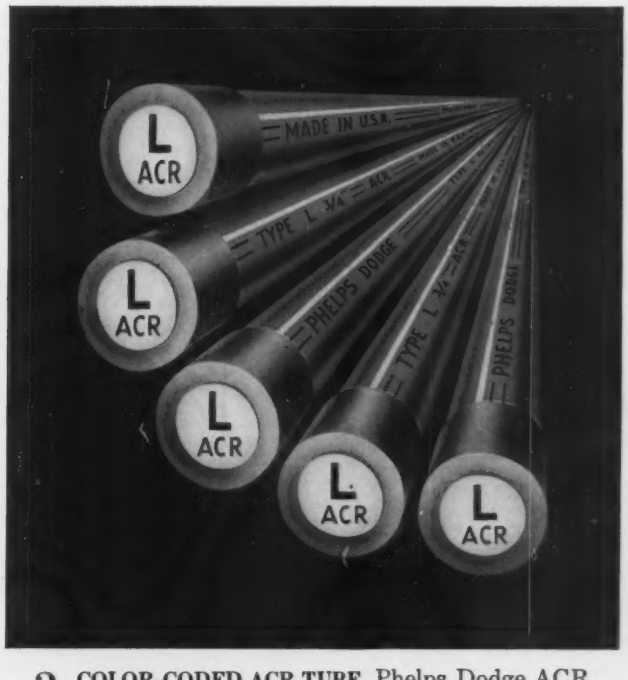
The Famous Mine-to-Market Quality Line!



1 HIGHEST GRADE COPPER. Phelps Dodge refrigeration tube is made of the finest copper from Phelps Dodge's own U.S. open-pit mines. Smelting and refining of the copper ore are also done by Phelps Dodge to assure lasting quality.



2 FINEST QUALITY CONTROL. Phelps Dodge refrigeration tube is carefully controlled for quality throughout fabrication, rigorously tested before being packaged to assure finest tube properties and lasting quality in service.



3 COLOR-CODED ACR TUBE. Phelps Dodge ACR tube is specially cleaned for refrigeration use. Extra-long coded end caps are your assurance of factory-clean tube at job site. Tube is color coded "ACR" for your protection.

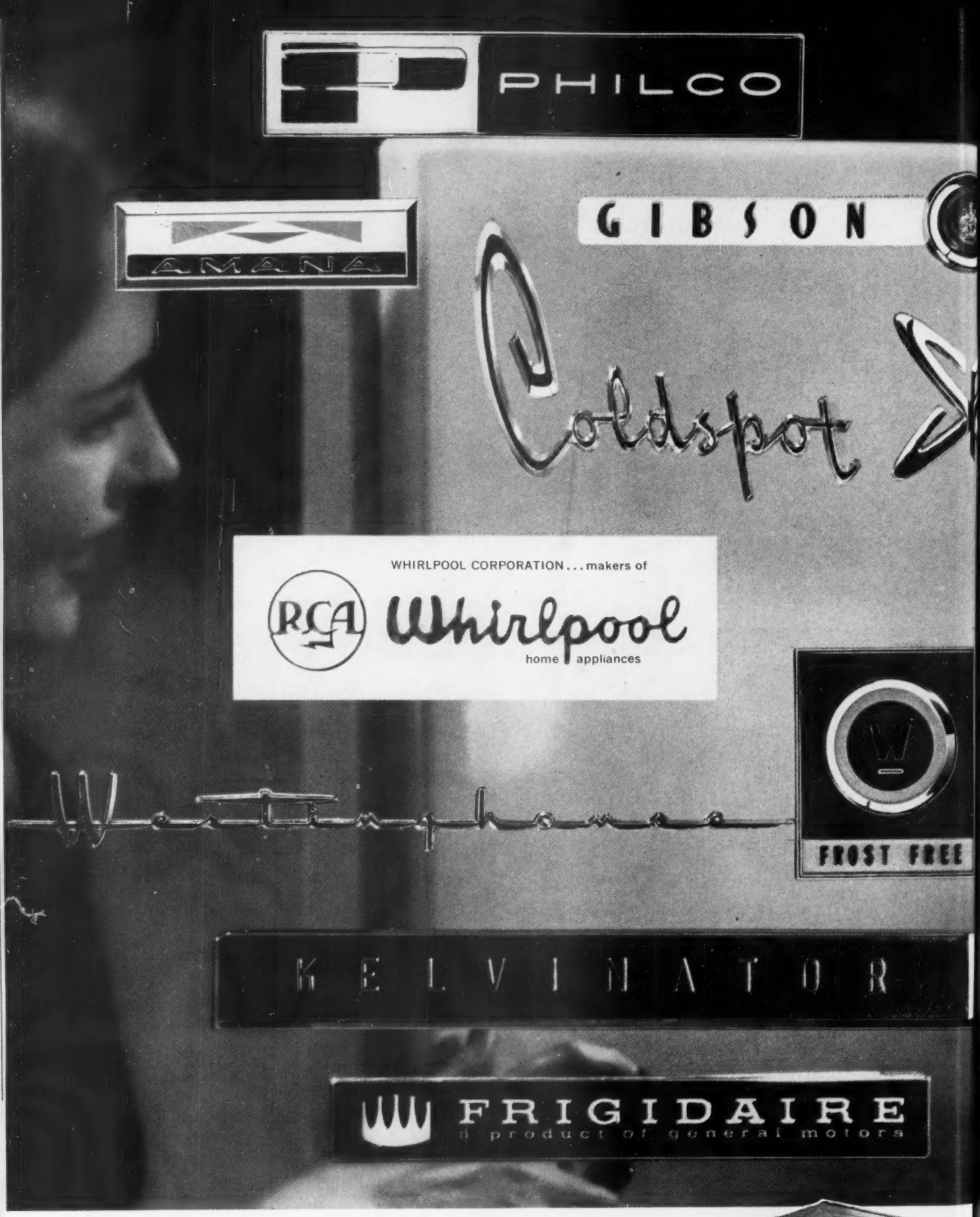
Quality tube sold the quality way—through authorized wholesalers!

AIR-CONDITIONING AND REFRIGERATION WHOLESALERS A·R·W ASSOCIATE MEMBER

PHELPS DODGE COPPER PRODUCTS CORPORATION

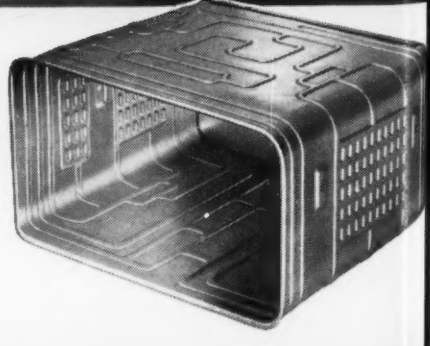
New York, N.Y. • Los Angeles, Calif.

PD



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evaporators by Olin



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ASHRAE JOURNAL
OFFICIAL PUBLICATION
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FEBRUARY 1961

Comment

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OUR SHOW

Time-honored, yet never to be taken for granted, Industry Shows have become one of the most important mediums for transmitting essential facts, about engineering progress and regarding equipment and component availabilities, from producers to specifiers and buyers. Differing from European Trade Fairs in their adaptation to the basic technical nature of specific offerings rather than to reflect merchandise as such, American Industry Shows are dynamic dramatizations of functional mechanizations.

To this broad generalization the forthcoming 15th International Heating and Air Conditioning Exposition in Chicago is no exception. As indicated tangibly elsewhere in this issue, the 1961 Show, held concurrently with the ASHRAE Semiannual Meeting, will be most extensive in its representation of manufacturers' activities and offerings. It, again, presents unparalleled opportunity for the alert engineer to keep pace with progressive improvement in several fast-moving and important industry groups.

Don't miss the Chicago Semiannual Meeting and be sure to attend the Show.

BOYS GROWN TALL

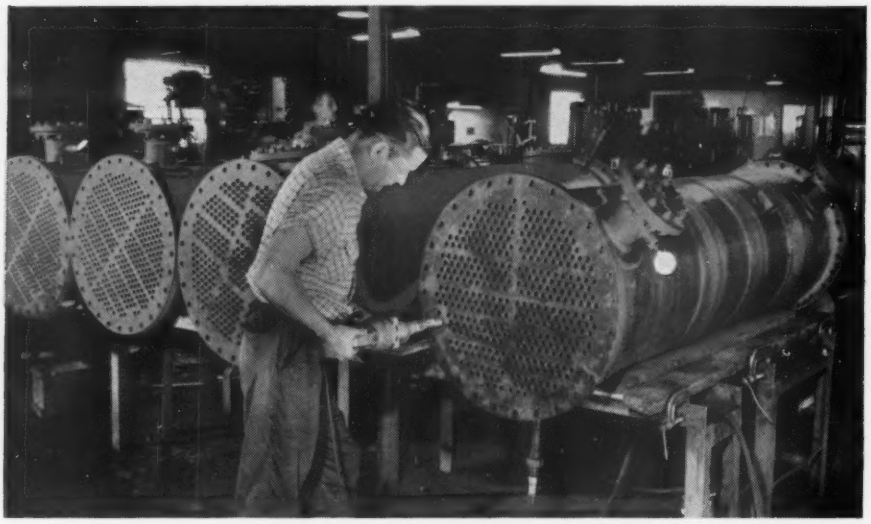
Just the other day, one of our members confronted us with his opinion that, apparently quite suddenly, the world and its peoples had become something new and even alarmingly different. It seemed to follow that everything he (and we) did must be correspondingly changed—and at once.

Well, we don't think so. For all the explosive characteristics of scientific, engineering and population growth of the past 200 years or so, we think people (as such) remain very much the same. Animated by the same urges, persuaded by the same arguments, obsessed with the same sometimes illogical reactions.

So, we prefer to think in terms of people; rather than primarily in terms of times, and to measure our contributions to the present with more regard to what people will do and feel under given circumstances than to what an artificially formulated timetable may seem to prescribe.

Edward R Searles
Editor

ANACONDA HEAT EXCHANGER CLINIC

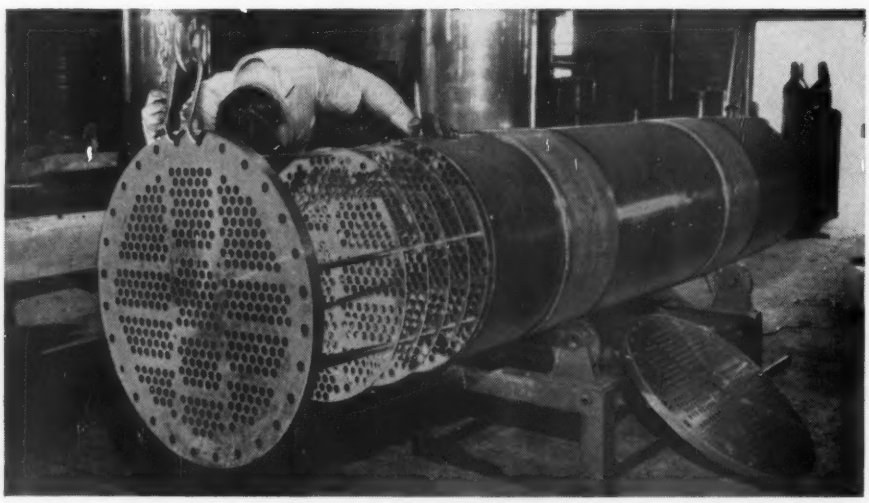


Dry-expansion water chillers nearing completion at Precision Heat Exchanger Co. for both Polaris-type and Thresher-type atomic submarines. Each vessel has two chillers. Here phosphorized copper tubes are being expanded into tube sheets of Everdur®, Anaconda copper-silicon alloy.

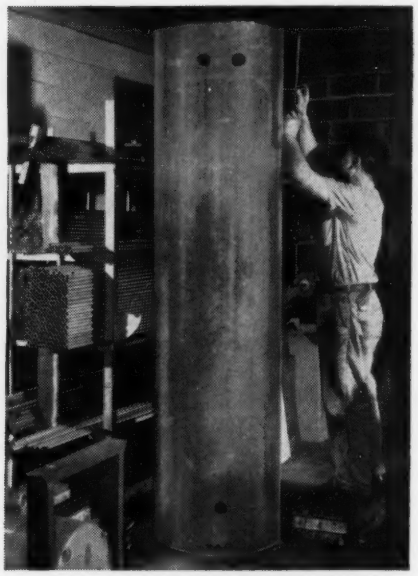
Big 24" I.D. seamless 85-15 Red Brass tubes serve as shells on water chillers for our nuclear submarines

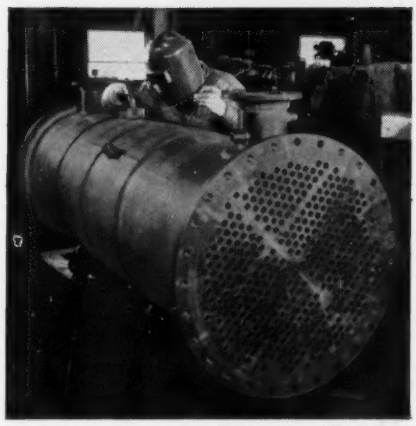
Many very special requirements dictated the design of the dry-expansion water chillers used in air conditioning our atomic submarines. They must be extremely compact to fit in very limited space. They must provide high corrosion resistance for utmost reliability in operation over long periods. And they have to be able to withstand the severe shocks and strains apt to be encountered in submarine service.

The chillers shown above are designed and built by Precision Heat Exchanger Co., Inc., of Westwood, N. J., for the York Division of Borg-Warner Corp., which is responsible for the over-all air conditioning systems. For the giant seamless tube which forms the shells of the chillers, Precision Heat Exchanger Co. turned to American Brass. And Mr. Hugh Eure, president, reports that despite their size and the hazards of shipping, the tubes have come through consistently round.



Inserting baffles and tube sheets into shell preparatory to tubing. Each chiller has 374 tubes of Phosphorized Copper-103, each 3/4" O.D. x .049" gage x 8 ft. long; 21 tube baffles of Yellow Brass, each 23 7/8" dia. x 1/8" thick; and tube sheets of Everdur-1010, each 28 3/8" dia. x 1 3/8" thick. Note mounting bands around center of shell. They are formed from 1/4" Everdur-1010 sheet and welded to the 85-15 Red Brass shell.





Top: Big seamless tube of Anaconda 85-15 Red Brass, 24" I. D. x 5/16" wall x 95 1/4" long, which will form shell of water chiller. Anaconda can produce seamless tube in commercial sizes up to 26.875" O.D. x .437" wall in length of 10 ft. for largest diameters, in copper and brass alloys. Everdur and Cupro Nickel are also available in slightly smaller diameters. Above: Welding an Everdur mounting bracket to the chiller by the metal-arc, inert-gas process.

TECHNICAL ASSISTANCE. The Metallurgical Department of Anaconda American Brass Company is regularly working with the manufacturers and users of heat transfer equipment helping to select the alloys best suited for the service. For technical help or information on alloys and tubes, write: Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 6073

ANACONDA®

Tubes and Sheets for Condensers and Heat Exchangers

Anaconda American Brass Company

Some Things to Look for at the ASHRAE Show

For four days, February 13-16, the 15th International Heating and Air Conditioning Exposition, at Chicago's International Amphitheatre, will parallel the Semiannual Meeting of ASHRAE at the Conrad Hilton.

The January Issue of your ASHRAE JOURNAL previewed the meeting.

This February Issue previews the show, presents a floor plan and lists Exhibitors with emphasis therein of JOURNAL advertisers.

Prospects for the greater residential, commercial and industrial growth of heating, air conditioning, ventilation, air purifying and refrigerating will be dramatized at the 15th International Heating and Air Conditioning Exposition, February 13 to 16, for new equipment covering every phase of these activities will be on display to stress available means for securing improved performance at lower cost.

This Exposition, sponsored by the American Society of Heating, Refrigerating and Air Conditioning Engineers, will present the equipment of more than 500 manufacturers; perhaps a record high.

Advance reports indicate that innovations in design will be numerous as many new products are unveiled in the fields of complete assemblies and units, as well as in components and materials. There are promised announcements of show items not yet in production but planned for the future.

Improvements within packaged products lead to simplified installations. One complete package idea is illustrated by a steel boiler complete even to preassembled piping harnesses. Another is a cast iron gas-fired boiler, designed for zone heating, shipped with zone valves, manifold and thermostats complete. Zone control piping is made up, ready for attachment. Circulator, control panel, aquastat, relay and transformer are in place. Wiring and all pipe fittings, ready to complete the installation, are also included.

A fan coil manufacturer will present a newly designed multi-zone air conditioner planned – in line with the current building trend – to conserve floor space; also a stainless steel spray type dehumidifier. Another emphasis, frequently encountered, will be upon efforts to assure quiet air conditioning and air moving equipment. Newcomer in sound absorbing equipment for air conditioning systems is a tuneable silencer to cancel out objectionable frequencies by adjustment.

An advanced type of duct consists of a glass fiber tube encased in a plastics vapor barrier, combines strength and rigidity with the thermal and sound absorbing properties of glass. This is made up in 6-ft lengths in standard galvanized sheet metal pipe sizes for easy installation in the field and is available for residential air conditioning systems and as a sound-absorbing connection between metal ducts and registers.

A line of centrifugal pumps for water supply and hot and cold water handling has been augmented by a new low noise level pump for apartment buildings.

Within an extensive line of devices to control vibration, shock and noise is an elastic damping compound for use in conjunction with isolators, flexible connections and duct silencers. This product extends the range in which sound energy may be checked at the source. It is sprayed or troweled on in less thicknesses than some of the so-called undercoaters to render sheet metal more closely equivalent acoustically to a sheet of cork. It is suitable for all products utilizing metal panels, such as air ducts, plenum boxes, diffusers, dampers, fan scrolls, pumps, compressors, motors and piping systems.

Air treating equipment in the way of moisture control, filtration and purification will include developments as well as the more familiar ones. Portable humidifiers, with atomization of water directly into the atmosphere or against a heating

coil, pace the evaporative type, permanently installed in the furnace.

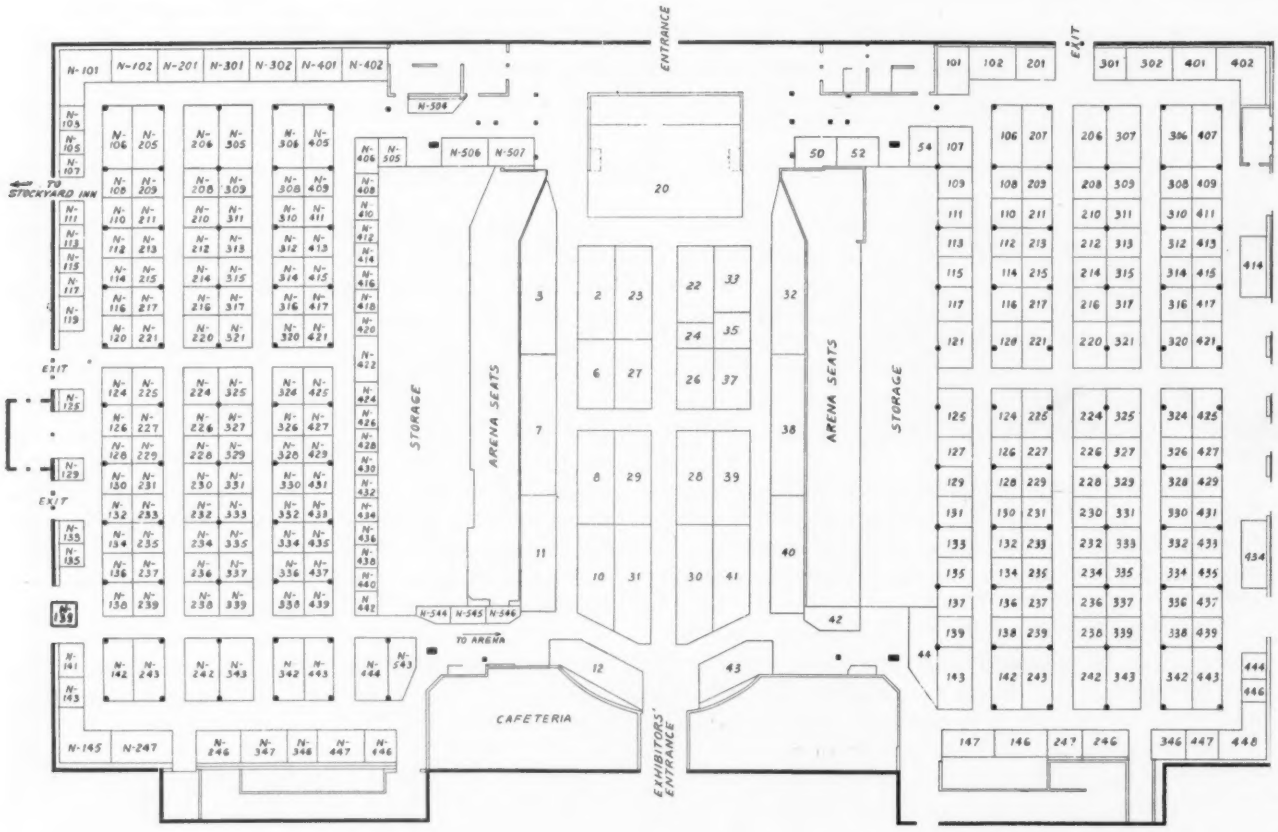
Air filter displays will include examples of the permanent dry panel electrostatic sheet in residential and industrial grades. There also will be a permanent filter impregnated with a germicide, which may be un-zippered and removed from its frame for cleaning.

To a line of air purifying equipment which utilizes the adsorptive properties of activated charcoal has now been added a deodorant paint, which may be sprayed on air filters to improve their performance. Another application of activated carbon deodorant is in the purification of return air in air conditioning systems. For large installations this method affords considerable long-term economies.

An ionizer design secures a maximum area of electron discharge in a high capacity air cleaning unit by providing the negative electrodes with a curved face. This, plus a reduction in spacing between the plates, tends to a better balance between spacing and voltage.

Another electronic air purifier attacks the problem of residual dust within an air-conditioned space by combining an electronic generator and a series of statically charged screens to produce a heavy bombardment and shattering of dust particles. Aerosols are discharged under negative ionization which prevents them from adhering to surfaces within the room. Intermingling with room dusts, dislodged by local air currents, they ionize the finer residual particles and so prevent the smudging characteristic of many air-conditioning installations.

Electric heating, formerly offered mainly for supplementary uses, has gained new strength and fits into the 1961 heating set-up with the backing of some 25 assorted displays. Several new applications are included.



	(Booth No.)
ACE ENGINEERING CO. 2850 W. Harrison St., Chicago 12, Ill.	936
ACKERMAN GAS BURNER CORP. South Main St. & P.R.R., McDonald, Pa.	N-134
ACME ENGINEERING & MANUFACTURING CORP. Muskogee, Okla.	1133
ACME INDUSTRIES, INC. 600 N. Mechanic St., Jackson, Mich.	854-864
ACTUAL SPECIFYING ENGINEER 1801 Prairie Ave., Chicago 16, Ill.	N-414, N-416
ADDISON PRODUCTS CO. Addison, Mich.	1110-1114
AEROQUIP CORP. 300 S. East Ave., Jackson, Mich.	120
AERONAUTICAL ELECTRONICS, INC. Raleigh, N. C.	214
AIR CONDITIONING & EQUIPMENT CORP. 219 E. 44th St., New York 17, N. Y.	1103
AIR CONDITIONING, HEATING & REFRIGERATION NEWS 450 W. Fort St., Detroit, Mich.	342
AIR CONDITIONING, HEATING & VENTILATING 93 Worth St., New York 13, N. Y.	751

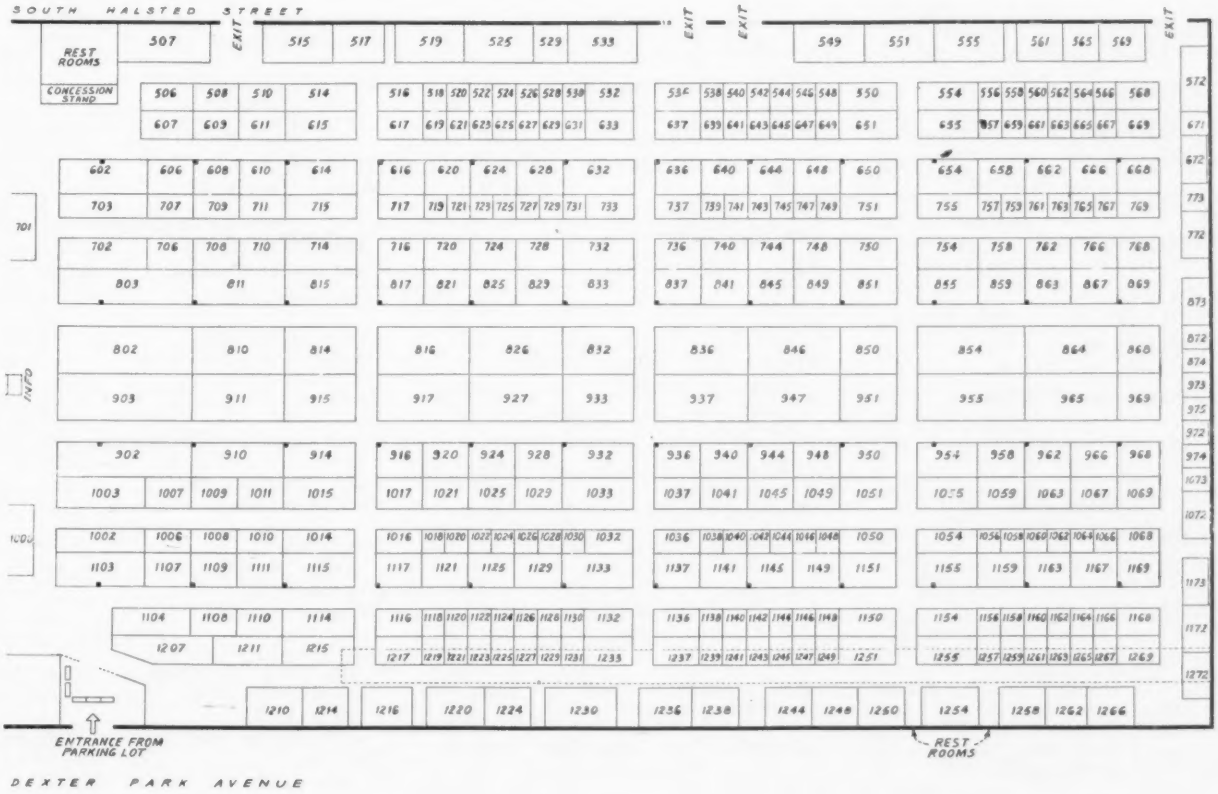
One air conditioning package has an electric coil heating unit as an option over the regular gas-fired heater section. A packaged forced-air electric heater for individual rooms is another innovation. The forced air unit may be installed between floor joists. Heat supply is controlled by a room thermostat.

Thermal insulations will include glass fiber duct wrap and liner, as well as sheet material for large pipes, vessels and pans, foamed plastics pipe covering and a rigid foam plastics covering strengthened for use as a load bearing material at pipe hanger locations, in underground lines and at other points where pipe covering may be subject to deformation.

Innovations in fans and blowers will be noteworthy, too. A line of vaneaxial fans with slotted blades is for applications where light weight, small size, low noise levels, minimum vibration and long life are critical. The prototype of this design was developed to fulfill the extraordinary noise and vibration limitations of the nuclear submarine.

A mixed axial-centrifugal fan combines the space-saving advantages of the axial type with the desirable performance characteristics of the backwardly inclined centrifugal. It is designed to produce a spin-free flow with uniform velocity throughout the duct area, and occupies 40% less space than the scroll type duct centrifugal. There will be a tubeaxial fan having a housing lined with bondable plastics. This will be shown in conjunction with an all-plastics air washer, which has been developed for the removal of noxious and poisonous fumes from chemical and other industrial plants.

Worthy of quote is a vacuum combustion system, within which a series of wholly enclosed gas burners with gas and air valves actuated by suction is connected to a common exhaust. This is offered primarily for low temperature radiant heating.



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AIR CONTROL PRODUCTS, INC. 407
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AIR DEVICES, INC. 1015
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AIR GUIDE PLASTICS CORP. 1046-1048
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St. Louis 10, Mo.

AMERICAN GAS ASSOCIATION 520-522 & 633
420 Lexington Ave.,
New York 17, N. Y.

AMERICAN GILSONITE CO. 841
238 N. Twenty-First West,
Salt Lake City, Utah

AMERICAN IRON AND STEEL INSTITUTE, COMMITTEE OF STEEL PIPE PRODUCERS 709
150 E. 42nd St.,
New York 17, N. Y.

AMERICAN METAL MFG. CO. 1056
First Ave.,
Dallas, Tex.

AMERICAN PULLMAN CO., INC. N-320
2455 N. Sheffield Ave.,
Chicago 14, Ill.

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC. 701
234 Fifth Ave.,
New York 1, N. Y.

AMERICAN-STANDARD AIR CONDITIONING DIV 26
40 W. 40th St.,
New York 18, N. Y.

CONTROLS DIV 24 & 106
5900 Trumbull Ave.,
Detroit 8, Mich.

INDUSTRIAL DIV 20-22
P.O. Box 58,
Roosevelt Park Annex,
Detroit 32, Mich.

PLUMBING AND HEATING DIV 23-27
40 W. 40th St.,
New York 18, N. Y.

AMERICAN TUBE & CONTROLS, INC. N-112
Box 329,
West Warwick, R. I.

AMERICAN WARMING & VENTILATING CO. 650
1017 Summit St.,
Toledo 4, Ohio

AMMERMAN CO., INC. 429
P.O. Box 182,
Stillwater, Minn.

ANDERSON, CO., V. D. DIV OF INTERNATIONAL BASIC ECONOMY CORP. 1018
1935 W. 96th St.,
Cleveland 2, Ohio

ANEMOSTAT CORP. OF AMERICA 29
10 E. 39th St.,
New York 16, N. Y.

ANSUL CHEMICAL CO. 966
1 Stanton St.,
Marinette, Wisc.

APEXTRO PRODUCTS CO. N-434
1821 N. Eastlake Ave.,
Los Angeles 31, Calif.

ARGO INDUSTRIES, INC. N-130, N-132
524 Wethersfield Ave.,
Hartford, Conn.

ARKLA AIR CONDITIONING CORP. 526-532
812 Main St.,
Little Rock, Ark.

ARKLON PRODUCTS CO. 766
P.O. Box 3501,
Cleveland 18, Ohio

ARKOS MANUFACTURING CO. DIV, ARNOLD A. KOSARIN & ASSOCIATES, INC. N-108
7310 Woodward Ave.,
Detroit 2, Mich.

ARMCO STEEL CORP. 1207
Middletown, Ohio

ARMSTRONG CORK CO. 1042-1044
Liberty & Charlotte Sts.,
Lancaster, Pa.

ARMSTRONG FURNACE CO., DIV OF NATIONAL UNION ELECTRIC CORP. 6
851 W. Third Ave.,
Columbus 8, Ohio

ARMSTRONG MACHINE WORKS 625-627
816 Maple St.,
Three Rivers, Mich.

ARMSTRONG STEAM TRAP CO. 625-627
816 Maple St.,
Three Rivers, Mich.

ARROW-HART & HEGEMAN ELECTRIC CO. 663-665
103 Hawthorn St.,
Hartford 6, Conn.

ARVIN INDUSTRIES, INC. N-230, N-232
Columbus, Ind.

ASCOT GAS WATER HEATERS INC. N-440
222 W. Pittsburgh Ave.,
Milwaukee 4, Wisc.

ASSOCIATED LABORATORIES, INC. N-126
26845 Southfield Road,
Lathrup Village, Mich.

AUER REGISTER CO. 1009
6600 Clement Ave.,
Cleveland 5, Ohio

AURORA PUMP DIV, NEW YORK AIR BRAKE COMPANY 568
629 Loucks St.,
Aurora, Ill.

AU-TEMP-CO CORPORATION, DIV OF HEAT-TIMER CORP. 425
657 Broadway,
New York 12, N. Y.

AUTO-FLO CORP. 302 & 401
12085 Dixie St.,
Detroit 39, Mich.

AUTOMATIC DEVICES DIV, AMERICAN MACHINE AND METALS, INC. N-504
714 Hillgrove Ave.,
Western Springs, Ill.

AUTOMATIC HUMIDIFIER DIV, STANDARD MANUFACTURING CO. N-129
Cedar Falls, Iowa

AVON TUBE DIV, HIGBIE MANUFACTURING CO. N-337
Rochester, Mich.

BACHARACH INDUSTRIAL INSTRUMENT CO. 1024
200 N. Braddock Ave.,
Pittsburgh 8, Pa.

BALTIMORE AIRCOIL CO., INC. 39
P.O. Box 7322,
Baltimore 27, Md.

BARBER-COLMAN CO., AIR DISTRIBUTION PRODUCTS DIV AUTOMATIC CONTROLS DIV 506-508
1300 Rock St.,
Rockford, Ill.

BARKE PRODUCTS INC. 446
501 Vineland Road,
Bay Village, Ohio

BARNEBY-CHENEY CO. 1111
Cassady at Eighth,
Columbus 19, Ohio

BARRY BLOWER CO. 720
3100 California St. N.E.,
Minneapolis, Minn.

BASO, INC. 851
730 N. Jackson St.,
P.O. Box 461,
Milwaukee 1, Wisc.

BASTIAN-MORLEY CO., INC. N-342
208 Truesdell Ave.,
La Porte, Ind.

BAYLEY BLOWER CO., DIV OF GREEN FUEL ECONOMIZER CO. INC. 1104
1817 S. 66th St.,
Milwaukee 14, Wisc.

BELL & GOSSETT CO. 911
8200 N. Austin Ave.,
Morton Grove, Ill.

BENDIX-WESTINGHOUSE AUTOMATIC AIR BRAKE CO. 309-311
950 E. Virginia St.,
Evansville 11, Ind.

BETHLEHEM FOUNDRY & MACHINE CO., DYNATHERM DIV N-224, N-226
Bethlehem, Pa.

BETTCHER MANUFACTURING CORP., PANELBLOC DIV 1223-1225
3106 W. 61st St.,
Cleveland 2, Ohio

BINKS MFG. CO. 1062-1064
3114-40 W. Carroll Ave.,
Chicago 12, Ill.

BLOOMER COOLING TOWER DIV, FISKE CO. N-335
1237 W. 47th St.,
Chicago 9, Ill.

BOHN ALUMINUM & BRASS CORP., DANVILLE DIV 606
Danville, Ill.

BOILER EQUIPMENT TRUST N-117
Amherst, Mass.

BOOTZ MANUFACTURING CO., INC. 232
1400 Park St.,
Evansville 7, Ind.

BOYLE ENGINEERING LABORATORY 745
7280 West Devon Ave.,
Chicago 31, Ill.

BRANDES COMPANY 763
2046 Winnebago St.,
Madison 4, Wisc.

BREIDERT CO., G. C. N-229
13690 Vaughn St.,
P.O. Box 1190,
San Fernando, Calif.

BROOKSIDE CORP. 52
McCordsville, Ind.

BROWN PRODUCTS CORP., A. 729
1090 Springfield Road,
Union, N. J.

BROWNING MANUFACTURING CO. 607
Maysville, Ky.

BRUNDAGE COMPANY 609-611
512 N. Park St.,
Kalamazoo 11, Mich.

BRYAN STEAM CORP. N-138
P.O. Box 364,
Peru, Ind.

BUENSOD-STACEY CORP. N-444
45 W. 18th St.,
New York 11, N. Y.

BUFFALO FORGE CO. 832-933
490 Broadway,
P.O. Box 985,
Buffalo 5, N. Y.

BURGESS-MANNING CO., ARCHITECTURAL PRODUCTS DIV 313-315
749 E. Park Ave.,
Libertyville, Ill.

BURKE AND CO. N-143
2902 Hyde Park Blvd.,
Los Angeles 43, Calif.

BURNHAM CORP.
Irvington, N. Y.
HEATING & COOLING DIV 714
STEEL BOILER DEPT 708-710
WARM AIR & COOLING DIV 796-708
4th & Main Sts.,
Belle Vernon, Pa.

BYERS CO., A. M. 1124-1126
Pittsburgh, Pa.

CRS INDUSTRIES, INC. 327
Suite 921, 1405 Locust St.,
Philadelphia 2, Pa.

CALGON CO., DIV OF HAGAN CHEMICALS & CONTROLS, INC. 755
Hagan Bldg.,
Pittsburgh 30, Pa.

CAMBRIDGE FILTER CORP. 914
738 Erie Blvd. E.,
P. O. Box 1255,
Syracuse 1, N. Y.

CARGOCAIRE ENGINEERING CORP. N-243
15 Park Row,
New York 38, N. Y.

CARNES CORP. 940
S. Main St.,
Verona, Wisc.

CARRIER AIR CONDITIONING CO. 549-569
Carrier Parkway,
Syracuse 1, N. Y.

CASH VALVE MANUFACTURING CORP., A. W. 707
666 E. Wabash,
Decatur, Ill.

CATERPILLAR TRACTOR CO. 524
Peoria, Ill.

CENTURY ELECTRIC CO. 915
1806 Pine St.,
St. Louis 3, Mo.

CENTURY ENGINEERING CORP. 962
221 Fourth Ave. S.E.,
Cedar Rapids, Iowa

CHACE COMPANY, W. M. 1030
1600 Beard Ave.,
Detroit 9, Mich.

CHAMPION BLOWER & FORGE CO. INC. 651
Lancaster, Pa.

CHATLEFF CONTROLS, INC. N-415
205 Industrial Blvd.,
P. O. Box 996,
Austin 66, Texas

CHICAGO BLOWER CORP. 602, 703
9867 Pacific Ave.,
Franklin Park, Ill.

CHICAGO PUMP, HYDRODYNAMICS DIV, FOOD MACHINERY & CHEMICAL CORP. 31
622 Diversey Parkway,
Chicago 14, Ill.

CHICAGO STEEL FURNACE CO. 649
2350 Lunt Ave.,
Elk Grove, Ill.

CHRYSLER CORP., AIRTEMP DIV 1159-1169
Dayton 1, Ohio

CLARAGE FAN CO. 810
1 Clarage Place,
Kalamazoo, Mich.

CLARK INDUSTRIES, INC. 108, 110
9701 S. E. McLoughlin Blvd.,
Portland 22, Ore.

CLAYTON MARK & CO. 334
1900 Dempster St.,
Evanston, Ill.

CLEAVER-BROOKS CO. 33
326 E. Keefe Ave.,
Milwaukee 12, Wisc.

CLEVELAND CONTROLS, INC. 1221
1111 Brookpark Road,
Cleveland 9, Ohio

CLEVELAND STEEL PRODUCTS CORP., TORIDHEET DIV 724, 728
16025 Brookpark Road,
Cleveland 35, Ohio

COBRA METAL HOSE DIV, D. K. MANUFACTURING CO. 1026-1028
5059 S. Kedzie Ave.,
Chicago 32, Ill.

COLEMAN CO., INC. 1245, 1247, 1249
250 N. St. Francis,
Wichita 1, Kansas

COLLINS MACHINERY CORP. N-347
955 Monterey Pass Road,
Monterey Park, Calif.

COLUMBIA BOILER CO. 655
Box 230, Pottstown, Pa.

COMBUSTION CONTROL DIV, ELECTRONICS CORP. OF AMERICA 12
1 Memorial Drive,
Cambridge, Mass.

COMMERCIAL FILTERS CORP. 411
2 Main St.,
Melrose 76, Mass.

COMMITTEE OF STEEL PIPE PRODUCERS, AMERICAN IRON AND STEEL INSTITUTE 709
150 E. 42nd St.,
New York 17, N. Y.

COMBUSTION ENGINEERING CORP. N-421
3511 W. Potomac Ave.,
Chicago 51, Ill.

CONNOR ENGINEERING CORP. 142
Shelter Rock Lane,
Danbury, Conn.

CONTINENTAL AIR FILTERS, INC. 1033
2520 Helm St.,
P.O. Box 1647, Louisville 1, Ky.

CONTINENTAL AUTOMATIC BOILER DIV OF BOILER ENGINEERING & SUPPLY CO. INC. N-443
Phoenixville, Pa.

CONTINENTAL MANUFACTURING CO 1173
P.O. Box 4048,
Baltimore 22, Md.

CONTRACTOR, N-546
230 W. 41st St.,
New York 36, N. Y.

CONTROLS CO. OF AMERICA, HEATING & AIR CONDITIONING DIV 803
2450 N. 32nd St.,
Milwaukee, Wisc.

COOK CO., LOREN 644
640 N. Rocky River Drive,
Berea, Ohio

COOL HEAT DIV, DRYING SYSTEMS CO. N-242
1800 Foster Ave.,
Chicago 40, Ill.

COOLERATOR DIV, MCGRAW-EDISON CO. 335-337
704 N. Clark,
Albion, Mich.

COPELAND REFIGERATION CORP. 515-517
Sidney, Ohio

CRANE CO., PLUMBING-HEATING-AIR CONDITIONING GROUP 825, 826, 829
P.O. Box 780, 924, 927, 928
Johnstown, Pa.

CURTIS MANUFACTURING CO., REFRIGERATION DIV 850, 951
1905 Kienlen Ave.,
St. Louis 20, Mo.

CUTLER-HAMMER, INC. 1155
315 N. 12th St.,
Milwaukee 1, Wis.

DANFOSS, INC. 135, 137, 139
115 Glen Ave.,
Lodi, N. J.

DEKORON PRODUCTS DIV, SAMUEL MOORE & CO. N-124
Main & Orchard Sts.,
Mantua, Ohio

DELAVAN MANUFACTURING CO. 1021
811 Fourth St.,
West Des Moines, Iowa

DELCO APPLIANCE DIV, GENERAL MOTORS CORP. N-330, N-332
391 Lyell Ave.,
Rochester, N. Y.

DELCO PRODUCTS DIV, GENERAL MOTORS CORP. N-145
Dayton 1, Ohio

DETROIT CONTROLS DIV, AMERICAN-STANDARD 24 & 106
Detroit 8, Mich.

DIEHL MANUFACTURING CO., FINDERNE PLANT N-433
Somerville, N. J.

DODGE CORP., F. W.
119 W. 40th St.,
New York 18, N. Y.

DOERR ELECTRIC CORP. 572
510 N. Fourth Ave.,
Cedarsburg, Wisc.

DOLE REFRIGERATING CO. 328
5910 N. Pulaski Road,
Chicago 46, Ill.

DOMESTIC ENGINEERING MAGAZINE N-414, N-416
1801 Prairie Ave.,
Chicago 16, Ill.

DONGAN ELECTRIC MANUFACTURING CO. N-111
2987-3001 Franklin St.,
Detroit 7, Mich.

DORNBACK FURNACE AND FOUNDRY CO. N-239
33220 Lakeland Blvd.,
Eastlake, Ohio

DORNBACK INDUSTRIES N-239
33220 Lakeland Blvd.,
Eastlake, Ohio

DRAVO CORP. 1258, 1262
Neville Island,
Pittsburgh 25, Pa.

DRAYER-HANSON DIV, HI-PRESS AIR CONDITIONING OF AMERICA, INC. 1172
3301 Medford St.,
Los Angeles 63, Calif.

DYER DYNAMICS CORP. 107
Page & Schuyler Aves.,
Lyndhurst, N. J.

DRYOMATIC CORP. 210
715 N. Fayette,
P.O. Box 591,
Alexandria, Va.

DUNHAM-BUSH, INC. 32
179 South St.,
West Hartford 10, Conn.

E. I. DUPONT DE NEMOURS & CO., "FREON" PRODUCTS DIV 1211
Wilmington 98, Del.

DURA-VENT CORP. 243
1400 W. Ormsby Ave.,
Louisville 10, Ky.

DURO-DYNE CORP. 772, 773
Route 110,
Farmingdale, N. Y.

DWYER MFG. CO., F. W. 1016
P.O. Box 373,
Woodland & Greenwood,
Michigan City, Ind.

DYNATHERM DIV, BETHLEHEM FOUNDRY & MACHINE CO. N-224, N-226
Bethlehem, Pa.

ECONO PRODUCTS CO. 1266
East Haddam, Conn.

EDWARDS ENGINEERING CORP. 624-628
101 Alexander Ave.,
Pompton Plains, N. J.

ELECTRIC BOAT DIV, GENERAL DYNAMICS CORP. 132-134
Groton, Conn.

ELECTRIC HEAT & AIR CONDITIONING, 968
2 W. 45th St.,
New York 36, N. Y.

ELECTRO-AIR CLEANER CO. 815
Olivia & Sproul Sts.,
McKees Rocks, Pa.

ELECTRO DYNAMIC DIV, GENERAL DYNAMICS CORP. 136
Bayonne, N. J.

ELECTROMODE DIV, COMMERCIAL CONTROLS CORP. 413, 415
570 Oliver Road,
P.O. Box 1052,
Rochester 3, N. Y.

ELECTRONICS CORP. OF AMERICA, COMBUSTION CONTROL DIV. 12
1 Memorial Drive,
Cambridge, Mass.

ELGEN MANUFACTURING CORP. 645, 647
32-49 Gale Ave.,
Long Island City 1, N. Y.

EMERSON ELECTRIC MFG. CO. 542-548
8100 Florissant Ave.,
St. Louis 21, Mo.

ENGEL SHEET METAL EQUIPMENT, INC. 101, 102, 201
8122 Reilly Ave.,
St. Louis 11, Mo.

ENGINEER'S PRODUCT FILE N-414, N-416
1801 Prairie Ave.,
Chicago 16, Ill.

ESSEX WIRE CORP., R-B-M CONTROLS DIV 1156
131 Godfrey,
Logansport, Ind.

EXCELSIOR STEEL FURNACE CO. N-324
546 W. Washington Blvd.,
Chicago 6, Ill.

FAIRBANKS MORSE & CO. 213, 215
600 S. Michigan Ave.,
Chicago 5, Ill.

FARR CO. 10
2301 Rosecrans Ave.,
El Segundo, Calif.

FASCO INDUSTRIES, INC. 737
225 N. Union St.,
P.O. Box 509,
Rochester 2, N. Y.

FEDDERS CORP., TRENTON DIV 702
Box 1690,
Trenton 7, N. J.

FEDERAL BOILER CO., INC. 11
Granite & West Sts.,
Midland Park, N. J.

FEE & MASON MFG. CO., INC. 717
21 Wyckoff Ave.,
Manasquan, N. J.

FELTER CO., JOHN N-505
1309 Ashland,
Houston, Texas

FIELD CONTROL DIV, CONCO ENGINEERING WORKS, INC. 732
Mendota, Ill.

FISKE CO., BLOOMER COOLING TOWER DIV N-335
1237 W. 47th St.,
Chicago 9, Ill.

FLANDERS FILTERS, INC. 536
P.O. Box 718,
Riverhead, N. Y.

FLEXIBLE TUBING CORP. 320
New Whitfield St.,
Guilford, Conn.

FLEXONICS CORP., SUB. OF CALUMET & HECLA, INC. 538-540
1315 S. 3rd Ave.,
Maywood, Ill.

FOOD MACHINERY AND CHEMICAL CORP., PEERLESS PUMP, HYDRODYNAMICS DIV 1272
301 W. Avenue 26,
Los Angeles 31, Calif.

FOREST CITY FOUNDRIES CO., NIAGARA FURNACE DIV N-506
2600 W. 27th St.,
Cleveland, Ohio

FRAM AIRE CORP DIV, FRAM CORP. 869
Providence 16, R. I.

FRICK CO. 1115
West Main St.,
Waynesboro, Pa.

FUELOIL & OIL HEAT 968
2 W. 45th St.,
New York 36, N. Y.

FULTON SYLPHON DIV, ROBERTSHAW-FULTON CONTROLS CO. 228-230
P.O. Box 400,
Knoxville 1, Tenn.

FURNAS ELECTRIC CO. 1146, 1148
1000 McKee St.,
Batavia, Ill.

GALLAHER CO. 562, 564
4108 Dodge St.,
Omaha 31, Nebr.

GAS HEAT & COMFORT HEATING 968
2 W. 45th St.,
New York 36, N. Y.

GENERAL AIR PRODUCTS CORP. 754
Stirling, N. J.

GENERAL AUTOMATIC PRODUCTS CORP. 121
2300 Sinclair Lane,
Baltimore 13, Md.

GENERAL BLOWER CO. 1045
8618 Ferris Ave.,
Morton Grove, Ill.

GENERAL CHEMICAL DIV, ALLIED CHEMICAL CORP. 43
2 Rector St.,
New York 6, N. Y.

GENERAL CONTROLS CO. 814
801 Allen Ave.,
Glendale 1, Calif.

GENERAL ELECTRIC CO., APPARATUS SALES DIV 736, 740, 744
1 River Road,
Schenectady 5, N. Y.

GENERAL FILTERS, INC. 762
43800 Grand River Ave.,
Novi, Mich.

GENERAL HEATING PRODUCTS CO. 414
7426 State Road,
Philadelphia 36, Pa.

GENERAL PRODUCTS CO., INC. N-338
Box 887,
Fredericksburg, Va.

GENERAL THERMO ELECTRIC CORP. N-246
Monmouth Junction, N. J.

GOODFELLOW CO., INC., E. D. 1269
496 E. Bodley Ave.,
Memphis 6, Tenn.

GORDON & PIATT, INC. N-543
P.O. Box 914,
Winfield, Kansas

GOVERNAIR CORP. 507
4840 N. Sewell,
Oklahoma City 18, Okla.

GRAYSON CONTROLS DIV, ROBERTSHAW-FULTON CONTROLS CO. 228-239
Long Beach Blvd.,
Long Beach 5, Calif.

GREENBECK FAN & VENTILATOR CORP. 310
Kelly Road,
Schofield, Wisc.

GREGORY INDUSTRIES, INC. N-325, N-327
28th St. & Toledo Ave.,
Lorain, Ohio

GULF OIL CORP. N-334, N-336
Gulf Bldg.,
P.O. Box 1166,
Pittsburgh 30, Pa.



GUSTIN-BACON MANUFACTURING CO. 50
210 W. 10th St.,
Kansas City 5, Mo.

H. & H. TUBE MANUFACTURING CO. 1238
245-275 N. Forman Ave.,
Detroit 17, Mich.

HALSTEAD & MITCHELL N-217
Bessemer Bldg.,
Pittsburgh 22, Pa.

HAMMOND VALVE CORP. 747
1844 Summer Blvd.,
Hammond, Ind.

HARRIS & CO., ARTHUR 721
210-218 N. Aberdeen St.,
Chicago 7, Ill.

HART & COOLEY MANUFACTURING CO. 1136
500 E. 8th St.,
Holland, Mich.

HASTINGS AIR CONTROL, INC. 863, 867
3215 Leavenworth St.,
Omaha 5, Nebr.

HAYS MANUFACTURING CO., AUTOMATIC CONTROLS DIV 1129
801 W. 12th St.,
Erie, Pa.

HEAT CONTROLLER, INC. 629-631
1900 Wellworth Ave.,
Jackson, Mich.

HEAT-TIMER CORP. 425
657 Broadway,
New York 12, N. Y.

HEATING & AIR CONDITIONING CONTRACTOR 731
92 Martlin Ave.,
Tarrytown, N. Y.

HEATING, PIPING & AIR CONDITIONING 723, 725
6 N. Michigan Ave.,
Chicago 2, Ill.

HEATING PUBLISHERS, INC. 968
2 W. 45th St.,
New York 36, N. Y.

HEIL PROCESS EQUIPMENT CORP. N-442
12901 Elmwood Ave.,
Cleveland 11, Ohio

HEIL-QUAKER CORP. 129, 131
647 Thompson Lane,
Nashville 4, Tenn.

HENRY FURNACE CO. 30, 41
Medina, Ohio

HENRY VALVE CO. 1217, 1219
3215 North Ave.,
Melrose Park, Ill.

HERCULES CHEMICAL CO. N-346
416 Broadway,
New York 13, N. Y.

HERRMIDIFIER CO. 127
1810 Hempstead Road,
Lancaster, Pa.

HIGHSIDE CHEMICALS, INC. 972, 974
10 Colfax Ave.,
Clifton, N. J.

HILD FLOOR MACHINE CO., INC. N-418
1217 W. Washington Blvd.,
Chicago 7, Ill.

HILTI, INC. N-431
73 Southfield Ave.,
Stamford, Conn.

HI-PRESS AIR CONDITIONING OF AMERICA, INC. 1172
405 Lexington Ave.,
New York 17, N. Y.

HOWELL ELECTRIC MOTORS CO. 1160-1162-1164
Howell, Mich.

HUBBELL CORP. 711
Hawley Road,
P.O. Box 700,
Mundelein, Ill.

HYDROTHERM, INC. 667, 669
Clinton Ave.,
Northvale, N. J.

ILG ELECTRIC VENTILATING CO. 1037, 1041
2850 N. Pulaski Road,
Chicago, Ill.

ILLINOIS ENGINEERING DIV, AMERICAN AIR FILTER CO. INC. 40
Racine Ave. at 21st St.,
Chicago 8, Ill.

ILLINOIS IRON & BOLT CO., FREEMAN HEATING DIV, AUTOMATIC SOLID FUELS DIV 306
Carpentersville, Ill.

ILLINOIS TESTING LABORATORIES, INC., ALNOR INSTRUMENT COMPANY DIV 672
420 N. LaSalle St.,
Chicago 10, Ill.

IMPERIAL BRASS MANUFACTURING CO., THE N-228
6300 W. Howard St.,
Chicago 48, Ill.

IMPERIAL DAMPER CO. N-328
664 Edgecombe Ave.,
New York 32, N. Y.

INDEPENDENT REGISTER CO. 739
3747 E. 93rd St.,
Cleveland 5, Ohio

INDUSTRIAL ACOUSTICS CO., INC. 1103
341 Jackson Ave.,
New York 54, N. Y.

INDUSTRIAL COMBUSTION, INC. 28
4507 N. Oakland Ave.,
Milwaukee 11, Wisc.

INDUSTRIAL ENGINEERING EQUIPMENT CO. N-438
24 Hanley Industrial Court,
St. Louis (Brentwood) 17, Mo.

INDUSTRIAL PLASTIC FABRICATORS, INC. 116
Endicott St.,
Norwood, Mass.

INDUSTRIAL PRESS 751
93 Worth St.,
New York 13, N. Y.

INGERSOLL-RAND CO. 259-611
11 Broadway,
New York 4, N. Y.

INSTO-GAS CORP. 1022
998 E. Woodbridge Ave.,
Detroit 7, Mich.

INTERNATIONAL HEATER CO. 811
101 Park Ave.,
Utica 2, N. Y.

IRON FIREMAN MANUFACTURING CO. 950, 1108
3170 W. 106th St.,
Cleveland 11, Ohio

ISOFLEX SALES CO. 727
1564 Rollins Rd.,
Burlingame, Calif.

JACKES-EVANS MFG. CO. N-227
4427 Geraldine Ave.,
St. Louis 15, Mo.

JANITROL HEATING & AIR CONDITIONING DIV, MIDLAND-ROSS CORP. 519-533
400 Dublin Ave.,
Columbus 16, Ohio

JENKINS BROS. 1230
100 Park Ave.,
New York 17, N. Y.

JENN-AIR PRODUCTS CO., INC. 833
1102 Stadium Drive,
Indianapolis 7, Ind.

JET-HEET, INC. N-313
152 S. Van Brunt St.,
Englewood, N. J.

JOHNS-MANVILLE SALES CORP. 447, 448
22 E. 40th St.,
New York 16, N. Y.

JOHNSON FURNACE CO. N-405
2129 W. 117th St.,
Cleveland 11, Ohio

JOHNSON HEATER CORP. 321
1 Winnisimmet St.,
Chelsea, Mass.

JOHNSON CO., S. T. N-446, N-447
P.O. Box 223,
Bridgeport, Pa.

JOHNSON SERVICE CO. 836, 937
507 E. Michigan St.,
Milwaukee 1, Wisc.

JOHNSTON BROTHERS, INC. 402
Ferrysburg, Mich.

JOURNAL OF PLUMBING, HEATING & AIR CONDITIONING 731
92 Martling Ave.,
Tarrytown, N. Y.

K S M PRODUCTS, INC. N-343
301 New Albany Road,
Moorestown, N. J.

KAISER ALUMINUM AND CHEMICAL CORP. 1010
300 Lakeside Drive,
Kaiser Center,
Oakland 12, Calif.

KENMORE MACHINE PRODUCTS, INC. 1236
Lyons, N. Y.

KEENEY PUBLISHING CO. 723, 725
6 N. Michigan Ave.,
Chicago 2, Ill.

KENNARD DIV, AMERICAN AIR FILTER CO., INC. 40
1819 S. Hanley Road,
St. Louis 17, Mo.

KIMBERLY-STEVENS CORP. N-326
1460 Broadway,
New York 36, N. Y.

KINGSTON-CONLEY, INC. 1160, 1162, 1164
900 North Ave.,
Plainfield, N. J.

KOPPERS COMPANY, INC., METAL PRODUCTS DIV 242
200 Scott St.,
Baltimore 3, Md.

KORFUND COMPANY, INC. 42
Cantiague Road,
Westbury, N. Y.

KOVEN & BROTHERS, INC., L. O. 143
90 E. Dickerson St.,
Dover, N. J.

KRESNO-STAMM CORP. N-333
Palisades Park, N. J.

KRITZER PRODUCTS DIV, PEERLESS OF AMERICA, INC. 1137
5800 N. Pulaski Road,
Chicago 46, Ill.

KRUEGER AIR CONDITIONING CO. 312, 314, 316
19 E. Rillito,
P. O. Box 5155,
Tucson, Ariz.

LAKE CHEMICAL CO. 237, 239
3052 W. Carroll Ave.,
Chicago 12, Ill.

LARKIN COILS, INC. 326
519 Memorial Drive, S. E.
Atlanta, Ga.

LAU BLOWER CO. 910
2027 Home Ave.,
Dayton 7, Ohio

LAUREL PRODUCTS INC. 212
P. O. Box 137,
River Falls, Wisc.

LAWLER AUTOMATIC CONTROLS, INC. 719
453 N. MacQuesten Parkway,
Mt. Vernon, N. Y.

LEECE-NEVILLE CO., GEORGIA DIV N-231
1400 Athens Highway,
Gainesville, Ga.

LEHIGH FAN & BLOWER DIV, FULLER CO. 1239, 1241
Catasauqua, Pa.

LELAND OHIO ELECTRIC CO. 1160, 1162, 1164
1501 Webster St.,
Dayton, Ohio

LENNOX INDUSTRIES, INC. N-206 to N-216 & N-305
200 S. 12th Ave.,
Marshalltown, Iowa

LENNOX TOOL AND MACHINE BUILDERS 1166
651 N. Baxter St.,
Lima, Ohio

LESLIE WELDING CO., INC. N-544
11241 W. Melrose St.,
Franklin Park, Ill.

LEWIN-MATHES CO. DIV, CERRO CORP. 434
1111 Chouteau Ave.,
St. Louis 2, Mo.

LIBERTY COMBUSTION CORP. N-133
East Molloy Road,
Industrial Park,
P.O. Box 300,
Syracuse 1, N. Y.

LIMA REGISTER CO. 1168
1790 N. Cable Road,
Lima, Ohio

LITTLE BURNER CO., H. C. N-342
208 Truesdell Ave.,
La Porte, Ind.

LOCKFORMER CO. 837
4615 W. Roosevelt Road,
Chicago 50, Ill.

MCALEAR MFG. CO. 748
1901 S. Western Ave.,
Chicago 8, Ill.

McDONNELL & MILLER, INC. 1000
3500 N. Spaulding Ave.,
Chicago 18, Ill.

MCGRAW-EDISON CO., COOLERATOR DIV 335, 337
704 N. Clark,
Albion, Mich.

MCINTIRE CO. 317
Okner Parkway,
Livingston, N. J.

MCLARTY SYSTEMS N-135
2600 Dickman Road,
Battle Creek, Mich.

McQUAY, INC. 802
1600 Broadway, N.E.
Minneapolis 13, Minn.

MCQUAY-NORRIS MANUFACTURING CO. N-316
2320 Marconi Ave.,
St. Louis 10, Mo.

MAGNETROL, INC. 1036
5399 Belmont Road,
Downers Grove, Ill.

MAID-O'-MIST, INC. 346
3217 N. Pulaski Road,
Chicago 41, Ill.

MAJOR CONTROLS CO. 1118
P.O. Box 537,
Corona, Calif.

MAMCO CORP. N-221
532-542 Fourth St.,
Racine, Wisc.

MAMMOTH INDUSTRIES, INC. 917
6425 Cambridge St.,
Minneapolis, Minn.

MAPLEWOOD DIV, ROCKFORD MACHINE TOOL CO. N-142
Rockford, Ill.

MARATHON ELECTRIC MANUFACTURING CORP. 1151
Wausau, Wisc.

MARKAL CO. 237-239
3052 W. Carroll Ave.,
Chicago 12, Ill.

MARLEY CO. 616-620
222 W. Gregory Blvd.,
Kansas City 14, Mo.

MARLO COIL CO. 1215
7100 S. Grand Ave.,
St. Louis 11, Mo.

MARSH INSTRUMENT CO., DIV OF COLORADO OIL AND GAS CORP. 639, 641, 643
109 Lanza Ave.,
Skokie, Ill.

MASTERCRAFT INDUSTRIES, INC. N-436
Garfield, N. J.

MAXITROL CO. 916, 920
23555 Telegraph Road,
Southfield, Mich.

MECHANICAL CONTRACTORS SUPPLY CO., INC. N-328
664 Edgecombe Ave.,
New York 32, N. Y.

MAIER ELECTRIC & MACHINE CO., INC. 44
3525 E. Washington St.,
Indianapolis 7, Ind.

MERCOID CORP. 35
4201 Belmont Ave.,
Chicago 41, Ill.

METALBESTOS DIV, WILLIAM WALLACE CO. 409
P.O. Box 137,
Belmont, Calif.

MID-CONTINENT METAL PRODUCTS CO. 1116
1960 N. Clybourn Ave.,
Chicago 14, Ill.

MIDLAND-ROSS CORP., JANITROL HEATING & AIR CONDITIONING DIV 519-533
400 Dublin Ave.,
Columbus 16, Ohio

MILWAUKEE ELECTRIC TOOL CORP. 1158
5216-20 W. State St.,
Milwaukee 8, Wisc.

MILWAUKEE VALVE CO. 227
2355-75 S. Burrell St.,
Milwaukee 7, Wisc.

MINE SAFETY APPLIANCES CO. 147
201 N. Braddock Ave.,
Pittsburgh 8, Pa.

MINNEAPOLIS-HONEYWELL REGULATOR CO. 965-969
2753 Fourth Ave. S.,
Minneapolis 8, Minn.

MODERN FLO-TROL PRODUCTS CORP. 741-743
367 Farmingdale Road,
Babylon, N.Y.

MODINE MANUFACTURING CO. 632
1500 DeKoven Ave.,
Racine, Wisc.

MONARCH MANUFACTURING WORKS, INC. 1050
2501 E. Ontario St.,
Philadelphia 34, Pa.



MONOGRAM INDUSTRIES, INC. 146
825 S. Front St.,
Quincy, Ill.

MOORE & CO., SAMUEL, KEKORAN PRODUCTS DIV N-124
Main & Orchard Sts.,
Mantua, Ohio

MORRISON PRODUCTS, INC. 554
16816 Waterloo Road,
Cleveland 10, Ohio

MT. HAWLEY MFG. CO. N-235
1209 W. Alta Road, Route 4,
Peoria, Ill.

MUELLER BRASS CO. 845, 849
1925 Lapeer Ave.,
Port Huron, Mich.

MUELLER CLIMATROL DIV, WORTHINGTON CORP. 1055, 1059
2005 W. Oklahoma Ave.,
Milwaukee, Wisc.

MULTI-VENT DIV, PYLE NATIONAL CO. 566
1334 N. Kostner Ave.,
Chicago 51, Ill.

N R C EQUIPMENT CORP. 114
160 Charlemont St.,
Newton 61, Mass.

NATIONAL HEATER CO., INC. 1250
2475 Doswell Ave.,
St. Paul 8, Minn.

NEEDCO GROUP OF CO. N-246
P.O. Box 253,
Princeton, N. J.

NELSON DIV, HERMAN, AMERICAN AIR FILTER CO., INC. 40
Louisville 8, Ky.

NEW YORK BLOWER CO. 816
32nd St. & Shields Ave.,
Chicago 16, Ill.

NIAGARA FURNACE DIV, FOREST CITY FOUNDRIES CO. N-506
2500 W. 27th St.,
Cleveland, Ohio

NIAGARA MACHINE & TOOL WORKS 817-821
636-697 Northland Ave.,
Buffalo 11, N. Y.

OCTAGON VENTILATOR MFG. CO. N-432
P.O. Box 1127,
Jackson, Tenn.

OHIO ELECTRIC MANUFACTURING CO. 1160, 1162, 1164
5400 Dunham Road,
Maple Heights, Ohio

OIL EQUIPMENT MANUFACTURING CORP. N-417
169 Derby Ave.,
New Haven 6, Conn.

OLSEN MANUFACTURING CO., C. A. 30, 41
Elyria, Ohio

ORR & SEMBOWER, INC. 207
Reading, Pa.

OSTER MANUFACTURING CO. 1233
1340 E. 289th St.,
Wickcliffe, Ohio

OWENS-CORNING FIBERGLAS CORP. 654
Toledo 1, Ohio

PARAGON ELECTRIC CO. 757
1600 Twelfth St.,
Two Rivers, Wisc.

PARKER BOILER MANUFACTURING CO., INC. N-225
2035 E. 37th St.,
Los Angeles 38, Calif.

PEERLESS OF AMERICA, INC. 1141
5800 N. Pulaski Road,
Chicago 46, Ill.

PEERLESS CORP. 8
1853 Ludlow Ave.,
Indianapolis 7, Ind.

PEERLESS ELECTRIC DIV, H. K. PORTER CO., INC. 206
1401 W. Market St.,
Warren, Ohio

PEERLESS HEATER CO. 1072, 1073
Boyertown, Pa.

PEERLESS MANUFACTURING DIV, DOVER CORP. 243
1400 W. Ormsby Ave.,
Louisville 10, Ky.

PEERLESS PUMP, HYDRODYNAMICS DIV, FOOD MACHINERY AND CHEMICAL CORP. 1272
301 W. Ave., 26,
Los Angeles 31, Calif.

PELNA ENGINEERING CORP. N-426
Box 8242,
Philadelphia 4, Pa.

PENN CONTROLS, INC. N-234, N-236, N-238
Goshen, Ind.

PENN VENTILATOR CO. 338
Goodman above Allegheny Ave.
Philadelphia 40, Pa.

PENNSALT CHEMICALS CORP., ISOTRON DIV 209, 211
Three Penn Center,
Philadelphia 2, Pa.

PENNSYLVANIA FURNACE & IRON CO. 128, 130
316 Pine St.,
Warren, Pa.

PERFECTION DIV, HUPP CORP. 1002
1135 Ivanhoe Road,
Cleveland 10, Ohio

PERMALIFE GLASS FIBER DIV, STANDARD ELECTRIC CO. N-141
3016 Austin Highway,
San Antonio 9, Texas

PEROLIN COMPANY, INC. 518
1112 W. 37th St.,
Chicago 9, Ill.
and 350 Fifth Ave.,
New York 1, N. Y.

PETRO 325
3170 W. 106th St.,
Cleveland 11, Ohio

PIONEER PRODUCTS DIV, WITCO CHEMICAL CO., INC. N-114
122 E. 42nd St.,
New York 17, N. Y.

PITTSBURGH CORNING CORP. N-128
1 Gateway Center,
Pittsburgh 22, Pa.

PITTSBURGH PLATE GLASS CO., FIBER GLASS DIV 125
632 Fort Duquesne Blvd.,
Pittsburgh 22, Pa.

PLAN HOLD CORP. 112
5204 Chakemco St.,
South Gate, Calif.

PLUMBING-HEATING-AIR CONDITIONING WHOLESALER 731
92 Martling Ave.,
Tarrytown, N. Y.

PLUMBING AND HEATING BUSINESS 1066
144 E. 44th St.,
New York 17, N. Y.

PORT CITY MACHINE & TOOL CO., MIPATAN DIV N-420
3590 Airline Road,
Muskegon, Mich.

POWER FLAME DIV, INC., SIEMON MANUFACTURING CO. 1120, 1122
1203 Main St.,
Grandview, Mo.

POWER LINE FAN CO. DIV, CHELSEA PRODUCTS, INC. 637
639 South Ave.,
Plainfield, N. J.

POWERS REGULATOR CO. 872, 873
3400 Oakton St.,
Skokie, Ill.

PUROLATOR PRODUCTS 117
970 New Brunswick Ave.,
Rahway, N. J.

PYLE-NATIONAL CO., MULTI-VENT DIV 566
1334 N. Kostner Ave.,
Chicago 51, Ill.

QUICKDRAFT CORP. 443
1650 W. Tuscarawas St.,
Canton 8, Ohio

R-B-M CONTROLS DIV, ESSEX WIRE CORP. 1156
131 Godfrey
Logansport, Ind.

RADIO CENTRAL CO. 214
1900 Shermer Ave.,
Northbrook, Ill.

RADIO CORPORATION OF AMERICA 417
Bldg. 15-1,
Camden 2, N. J.

RAMSET FASTENING SYSTEM, WINCHESTER-WESTERN DIV, OLIN MATHIESON CHEMICAL CORP. 220
289 Winchester Ave.,
New Haven 4, Conn.

RANCO, INC. 855
601 W. Fifth Ave.,
Columbus 1, Ohio

RANDALL GRAPHITE BEARINGS, INC. 1007
Box 839,
Lima, Ohio

RAY OIL BURNER CO. 229-231
1301 San Jose Ave.,
San Francisco 12, Calif.

RAYPAK CO., INC. N-125
2231 Chico Ave.,
El Monte, Calif.

READY POWER CO. 633
11231 Freud Ave.,
Detroit 14, Mich.

REED UNIT FANS, INC. 216
501 N. Saint Patrick St.,
New Orleans 19, La.

REFRIGERATION & AIR-CONDITIONING BUSINESS 1008
812 Huron Road,
Cleveland 15, Ohio

REFRIGERATION RESEARCH N-306
525 N. Fifth St.,
Brighton, Mich.

REPUBLIC PRODUCTS CO. 414
7426 State Road,
Philadelphia 36, Pa.

RESEARCH PRODUCTS CORP. 1017
1015 E. Washington Ave.,
Madison 1, Wisc.

REVCOR, INC. 1068
251 Edwards St.,
Carpentersville, Ill.

RHEEM MANUFACTURING CO. 662, 666
7600 S. Kedzie Ave.,
Chicago 29, Ill.

RIC-WIL INC. 516
P.O. Box 29,
Barberton, Ohio

RIDGE TOOL CO. 636, 640
400 Clark St.,
Elyria, Ohio

ROBERTS-GORDON APPLIANCE CORP. 1231
44 Central Ave.,
Buffalo 6, N. Y.

ROBERTSHAW-FULTON CONTROLS CO. 228, 230
911 E. Broad St.,
Richmond 19, Va.

FULTON SYLPHON DIV
P.O. Box 400,
Knoxville 1, Tenn.

GRAYSON CONTROLS DIV
Long Beach Blvd.,
Long Beach 5, Calif.

ROBERTSON CO., H. H. 301
2400 Farmers Bank Bldg.,
Pittsburgh 22, Pa.

ROBINAIRE MANUFACTURING CORP. N-233
1224 South East Ave.,
Montpelier, Ohio

ROTHERM ENGINEERING CO., INC. 745
7280 W. Devon Ave.,
Chicago 31, Ill.

ROYAL MANUFACTURING CO. N-137
622 Washington Square Bldg.,
Royal Oak, Mich.

RUBATEX DIV, GREAT AMERICAN INDUSTRIES N-209
Bedford, Va.

S.O.S. PRODUCTS CO., INC. N-125
346-350 Cumberland St.,
Brooklyn 38, N. Y.

SAFE-GUARD CORP. N-107
Lansdale, Pa.

SARCO CO., INC. 615
635 Madison Ave.,
New York 22, N. Y.

SARCOTHERM CONTROLS, INC. 615
635 Madison Ave.,
New York 22, N. Y.

SCHEMENAUER MANUFACTURING CO. 1263, 1265, 1267
Holland, Ohio

SCHNAKE, INC. 975
1101 N. Governor,
Evansville 7, Ind.

SCULLY SIGNAL CO. 417
174 Green St.,
Melrose 76, Mass.

SEABOARD PRODUCTS CORP. N-237
191 Frelinghuysen Ave.,
Newark 5, N. J.

SENNA MANUFACTURING CO. N-545
North 732 Napa St.,
Spokane 24, Wash.

SHAW-PERKINS MANUFACTURING CO. N-113, N-115
201 E. Carson St.,
Pittsburgh 19, Pa.

SHENANGO REFRACTORIES N-412
Box 120,
New Castle, Pa.

SILVERCOTE PRODUCTS, INC. N-428
161 E. Erie St.,
Chicago 11, Ill.

SKUTTLE MANUFACTURING CO. 668
Milford, Mich.

SLANT/FIN RADIATOR CORP. 435, 437, 439
130-15 89th Road,
Richmond Hill 18, N. Y.

SMITH CORP., A. O. 1130, 1132
P.O. Box 584,
Milwaukee 1, Wisc.

SMITH CORP., A. O. 522
P.O. Box 28,
Kankakee, Ill.

SMITH CO., INC., H. B. 614
Main St.,
Westfield, Mass.

SNIPS MAGAZINE N-139
5707 W. Lake St.,
Chicago 44, Ill.

SOUTHWEST MANUFACTURING CO. 608, 610
Aurora, Mo.

SPARTAN CONVECTOR CO., INC. 308
52-55 74th St.,
Maspeth 78, N. Y.

SPIRO U. S. A., INC. N-205
20 N. Wacker Drive,
Chicago 6, Ill.

SPORLAN VALVE CO. 1254
7525 Sussex Ave.,
St. Louis 17, Mo.

SPRAGUE ELECTRIC CO. 1227, 1229
97 Marshall St.,
North Adams, Mass.

SPRAYING SYSTEMS CO. 758
3201 Randolph St.,
Bellwood, Ill.

SQUARE D CO. 510
4041 N. Richards St.,
Milwaukee 12, Wisc.

STANDARD EQUIPMENT CORP., DIV OF HEAT-TIMER CORP. 425
657 Broadway,
New York 12, N. Y.

STANDARD REFRIGERATION CO. 307
3535 W. Fillmore St.,
Chicago 24, Ill.

STANDARD STAMPING & PERFORATING CO. 1054
3131 W. 49th Place,
Chicago 32, Ill.

STANLEY ELECTRIC TOOLS DIV, THE STANLEY WORKS N-435
New Britain, Conn.

STAR EXPANSION INDUSTRIES CORP. 208
P.O. Box 108,
Mountainville, N. Y.

STEINEN MFG. CO., WM. HEATING PRODUCTS DIV, INDUSTRIAL NOZZLE DIV 1244
43 Bruen St.,
Newark 5, N. J.

STEPHENS-ADAMSON MFG. CO., SEALMASTER DIV 133, 1251
Aurora, Ill.

STEWART-WARNER CORP., HEATING & AIR CONDITIONING DIV 1150
Lebanon, Ind.

STODDARD INDUSTRIES 427
3383 E. Layton Ave.,
Cudahy, Wisc.

STOKERMATIC CO. 336
1610 Industrial Road,
Salt Lake City, Utah

STRONG, CARLISLE & HAMMOND 1128
508 Sandusky St.,
Conneaut, Ohio

SUNDSTRAND HYDRAULICS DIV, SUNDSTRAND CORP. 617, 619
2210 Harrison Ave.,
Rockford, Ill.

SUN-RAY BURNER MANUFACTURING CORP. 715
139-24 Queens Blvd.,
Jamaica 35, N. Y.

SWARTOUT FABRICATORS INC. 1014
100 E. North St.,
Kokomo, Ind.

SYNCHRONOUS FLAME, INC. N-103, N-105
227 N. Main St.,
Walworth, Wisc.

TACO HEATERS INC. 1011
1160 Cranston St.,
Cranston 8, R. I.

TANN CORP., CONGRESS DRIVES DIV, TANN BEARING DIV N-427
3750 E. Outer Drive,
Detroit 34, Mich.

TECUMSEH PRODUCTS CO. 339, 343
Tecumseh, Mich.

TELEVANCE CORP. 444
P.O. Box 3043,
St. Louis 23, Mo.

TEMCO, INC. 621, 623
4101 Charlotte Ave.,
Nashville 9, Tenn.

THATCHER FURNACE CO. 1025, 1029
Garwood, N. J.

THERMAC CO. 944
14296 E. 6th St.,
Corona, Calif.

THERMAL ENGINEERING CORP. 124 & 225
2605 W. Dallas Ave.,
P.O. Box 13254,
Houston 19, Texas

THERMO-PAK BOILERS, INC. N-429
404 S. Palm Ave.,
Alhambra, Calif.

THERMO-PRODUCTS, INC. N-220
North Judson, Ind.

THERMOTANK, INC., AIR PRODUCTS DIV 761
11191 Lappin Ave.,
Detroit 34, Mich.

THERMO-WHEEL, INC. N-119
10-10 50th Ave.,
Long Island City 1, N. Y.

THRUSH & CO., H. A. 733
W. 8th at N. Jefferson St.,
Peru, Ind.

TITUS MANUFACTURING CORP. 902
P.O. Box 810,
Waterloo, Iowa

TJERNLUND MANUFACTURING CO. N-211, N-213, N-215
2140 Kasota Ave.,
St. Paul 8, Minn.

TOLEDO PIPE THREADING MACHINE CO. 233
P.O. Box 1678,
1425 Summit St.,
Toledo 3, Ohio

TORRIDHEET DIV, CLEVELAND STEEL PRODUCTS CORP. 724, 728
16025 Brookpark Road,
Cleveland 35, Ohio

TORRINGTON MANUFACTURING CO. 947
100 Franklin Drive,
Torrington, Conn.

TRANE CO. 3, 7
LaCrosse, Wisc.

TRERICE CO., H. O. N-408, N-410
1420 W. Lafayette Blvd.,
Detroit 16, Mich.

TRIANGLE ENGINEERING CO. N-505
1309 Ashland,
Houston 8, Texas

TRION, INC. N-507
1000 Island Ave.,
McKees Rocks, Pa.

TRIPLEX HEATING SPECIALTY CO., INC. 126
P.O. Box 358,
Peru, Ind.

TUTTLE & BAILEY DIV, ALLIED THERMAL CORP. 768
New Britain, Conn.

TUTTLE ELECTRIC PRODUCTS, INC. N-339
Kirkland, Ill.

TUTTLE & CO., H. W. 671
Tecumseh, Mich.

TYPHOON AIR CONDITIONING DIV, HUPP CORP. 234, 236, 238
505 Carroll St.,
Brooklyn 15, N. Y.

UNION CARBIDE DEVELOPMENT CO., DIV OF UNION CARBIDE CORP. 948
270 Park Ave.,
New York 17, N. Y.

UNION DAMPER CO. N-136
Union, Ill.

UNITED SHEET METAL CO., INC. 874, 973
883 N. Cassady Ave.,
Columbus 19, Ohio

UNITED STATES AIR CONDITIONING CORP. 648
P.O. Box 360,
Delaware, Ohio

UNITED STATES GYPSUM CO. N-120
300 W. Adams St.,
Chicago 6, Ill.

UNITED STATES REGISTER CO. 1032
344 W. Burnham St.,
Battle Creek, Mich.

UNIVERSAL DIFFUSER CORP. 1149
38 Marbledale Road,
Tuckahoe, N. Y.

VAN DORN IRON WORKS CO., INFRA RED DIV N-116
2685 E. 79th St.,
Cleveland 4, Ohio

VAN-PACKER CO., DIV OF FLINTKOTE CO. N-424
1232 McKinley Ave.,
Chicago Heights, Ill.

VAPOR HEATING CORP. 331
80 E. Jackson,
Chicago 4, Ill.

VENTFABRICS INC. 421
640 N. Kedzie Ave.,
Chicago 12, Ill.

VERNCO CORP. 226
Columbus, Ind.

VIBRATION ELIMINATOR CO. 1259
10-28 47th Ave.,
Long Island City 1, N. Y.

VIBRATION MOUNTINGS INC. 658
98-25 50th Ave.,
Corona 68, N. Y.

VIKING AIR PRODUCTS DIV, LAU BLOWER CO. N-409, N-411
5601 Walworth Ave.,
Cleveland 2, Ohio

VILTER MANUFACTURING CO., THE 329
2217 S. First St.,
Milwaukee 7, Wisc.

VULCAN RADIATOR CO. 846
775 Capitol Ave.,
Hartford 6, Conn.

W-M MANUFACTURING CO. N-413
4505 W. Armitage Ave.,
Chicago 39, Ill.

WAGNER ELECTRIC CORP. 1109
6400 Plymouth Ave.,
St. Louis 33, Mo.

WALKER MFG. & SALES CORP. N-308, N-310
1711 Penn St.,
St. Joseph, Mo.

WILLIAM WALLACE CO., METALBESTOS DIV 409
P.O. Box 137,
Belmont, Calif.

WALTON LABORATORIES, INC. 37
1186 Grove St.,
Irvington 11, N. J.

WALWORTH CO. N-309
750 Third Ave.,
New York 17, N. Y.

WARREN ENGINEERING CO., DIV OF WARREN AUTOMATIC CONTROLS CORP. 1243
Main St.,
Broadway, N. J.

WATERLOO REGISTER CO., INC. 29
Waterloo, Iowa

WATERMAN-WATERBURY CO. 324
1121 Jackson St. N.E.,
Minneapolis 13, Minn.

WATTS REGULATOR CO. 224
10 Embankment St.,
Lawrence, Mass.

WAUKESHA MOTOR CO. 1125
Waukesha, Wisc.

WEATHERHEAD CO., THE, FORT WAYNE DIV 769
128 W. Washington Blvd.,
Fort Wayne, Ind.

WEBSTER ELECTRIC CO. 1107
Clark & DeKoven Sts.,
Racine, Wisc.

WARREN WEBSTER & CO., INC. 1138, 1144
17th & Federal Sts.,
Camden 5, N. J.

WEIL-McLAIN CO. 903
Michigan City, Ind.

WEIL PUMP CO. 954, 958
1530 N. Fremont St.,
Chicago 22, Ill.

WELBILT AIR CONDITIONING AND HEATING CO. 750
Route 524, Lakewood Road,
Farmingdale, N. J.

WELTY-WAY PRODUCTS, INC. N-106
714 First Ave., N. W.,
Cedar Rapids, Iowa

WESTERN BOILER CO. 229, 231
47 Rousseau St.,
San Francisco 12, Calif.

WESTERN SUPPLY CO. 138
315 W. 3rd,
Box 784,
Hutchinson, Kans.

WESTINGHOUSE ELECTRIC CORP., AIR CONDITIONING DIV
Box 510,
Staunton, Va.

WESTINGHOUSE ELECTRIC CORP. 2
MOTORS & CONTROL,
Buffalo, N. Y.

WHO'S WHO IN ASHRAE

Insofar as possible these listings will each appear twice a year

ASHRAE OFFICERS, DIRECTORS COMMITTEES, STAFF

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REGION AND CHAPTER OFFICERS

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RESEARCH AND TECHNICAL COMMITTEES

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STANDARDS PROJECTS

See page 74, January JOURNAL

INTER SOCIETY COMMITTEES

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WHEEL TRUEING TOOL CO., TRUCO DRILLING DIVISION 1255
3200-3220 W. Davison Ave.,
Detroit 38, Mich.

WHITE-RODGERS CO. 1117, 1121
9797 Reavis Road,
St. Louis 23, Mo.

WIEGAND CO., EDWIN L. 1237
7500 Thomas Blvd.
Pittsburgh 8, Pa.

WILL-BURT CO., THE N-329, N-331
202 S. Main St.,
Orrville, Ohio

WILLIAMS OIL-O-MATIC HEATING CO., DIV OF NATIONAL UNION ELECTRIC CORP. 550
851 W. Third Ave.,
Columbus 8, Ohio

WILLIAMSON CO. 109, 115
3500 Madison Road,
Oakley, Cincinnati 9, Ohio

WING MFG., CO., L. J., DIV OF AERO SUPPLY MFG. CO. INC. 1003
Linden, N. J.

WIREMOLD COMPANY, THE N-439
Hartford 10, Conn.

WITCO CHEMICAL CO. INC., PIONEER PRODUCTS DIV N-114
122 E. 42nd St.,
New York 17, N. Y.

WOLVERINE TUBE DIV, CALUMET & HECLA, INC. 1154
17200 Southfield Road,
Allen Park, Mich.

WORLEY EQUIPMENT, INC. 221
2301 N. Knox Ave.,
Chicago 39, Ill.

WORTHINGTON CORP. 1063, 1067, 1069
401 Worthington Ave.,
Harrison, N. J.

XXth CENTURY HEATING & VENTILATING CO. 1006
96 Ira Ave.,
Akron 1, Ohio

YEATS APPLIANCE DOLLY SALES CO. N-406
2124 N. 12th St.,
Milwaukee 5, Wis.

YORK CORP. 1210, 1224
York, Pa.

YORK-SHIPLEY, INC.
York, Pa.
GENERAL DIV N-301
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How a heat pump

Improved Water Conditions

at a fish hatchery



FREDERICK S. ERDMAN
Member ASHRAE

Manipulation of temperatures of hatchery water supplies is sometimes beneficial in fish culture. Heating the water even a small amount during the winter months will result in a shorter incubation period for salmonid eggs and in more desirable temperature conditions for the feeding of fry; cooling the water during the summer months promotes better growth of the young fish. Such conditioning of the water has been put into effect at the experimental fish hatchery operated by the Department of Conservation at Cornell University in an attempt to develop a more efficient cultural procedure for fresh water or landlocked salmon (Salmo salar).

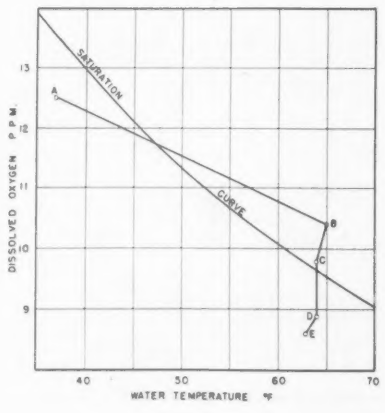
Water used in the Cornell hatchery comes from Cascadilla Creek. It is of poor quality for trout culture and the normal seasonal temperature range near the hatchery is 32 to 85 F. The portion of the brook water that is diverted for indoor use is first passed through an underground settling and tempering tank where in summer it is slightly cooled and in winter it is slightly warmed by heat transfer to and from the ground. Even after this slight tempering, the water supply to the troughs averages about 35 F in winter and 72 F in summer.

Experience with the conditioning system has shown a reduced incubation period and a growth rate of the fry roughly double what it was with untreated water.

In order to provide better incubation and growth conditions in the indoor hatchery facilities, it was decided that the water temperature in winter should be raised about 20 F and in summer lowered about 10 F. In addition, it was specified by the Department of Conservation that the quantity treated should be between 6 and 12 gpm. This problem was turned over to the Thermal Engineering Department of the School of Mechanical Engineering at Cornell University for solution.

The problem quickly resolved itself into a heat pump application.

Fig. 1 Oxygen concentration in water as affected by first warming and then agitating the water



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However, heating the water introduced a complication. Cold water, nearly saturated with air in the brook, becomes supersaturated as its temperature is raised, and increasing the temperature more than 5 F with electric immersion heaters had resulted previously in severe gas edema in the young fish. High mortality of fry occurred, and there was "pop-eye" and some mortality in larger fish. Hence the total problem included the reduction of air in solution in winter.

The heat pump would accomplish heating in winter and cooling in summer. Two heat exchangers, one as an evaporator in summer to cool the brook water and as the condenser in winter to heat it, the other to serve as condenser in summer to dissipate the heat and in winter as evaporator to absorb heat from some source, and a refrigerant compressor would be needed.

It was decided that the heat sink in summer (cooling water for the condenser) should, logically, be the cooled water discharged from the fish troughs. And, in winter the heat source (warming water for the evaporator) should be the warmed water discharged from the troughs. However, this arrangement, with fixed exchangers relative to water, would require complex piping and valving for the refrigerant with a high cost for refrigerant valves. So that plan was abandoned in favor of a fixed refrigerant system, with one exchanger serving always as evaporator and the other as condenser, while the water flow was alternated. This again required a complex piping and valving system, but with less expensive valves.

Calculations showed that a five-hp condensing unit would cool adequately the 10 F. For the 20 F heating in winter a considerably

larger unit would be necessary. In order to use the same unit for both seasons, the 5-hp unit with supplementary electric resistance heating in winter was decided upon.

DEAERATION OF WATER

Supersaturation and its elimination were studied. As is well known, gases are more readily soluble in cold water than in warm. Therefore, the brook water, exposed to a cold atmosphere for considerable time and with much agitation, becomes saturated, or nearly so, with oxygen and nitrogen. When this water is warmed, its capacity for holding air in solution is reduced. However, the excess air does not immediately go out of solution. Either time or agitation is required. Obviously, in this case, time is limited, as the flow is continuous.

Several methods of agitation were examined and, after trying such methods as free falling or cascading, discharging the water through spray nozzles at high velocity against a flat surface was found to be most effective. Hence, the system for conditioning the water in winter was designed to include a tank in which are placed nozzles that cause the warmed water to impinge as spray on its walls. Fig. 1 shows the solubility limits of oxygen (or air) in water at different temperatures. The solubility of nitrogen, which is more difficult to measure, was assumed to be similar to that of oxygen. Line ABCDE, in this illustration, shows the results of a test made on a day when the brook water reached the hatchery at 37 F with an oxygen content of 11.5 ppm, (point A). During the warming process, which was carried on in an open tank with immersion heaters, the temperature was raised to 65 F, bringing the solution to an unstable, supersaturated condition at point B with a drop in dissolved air to 10.4 ppm. A rotary type pump then discharged the water through a nozzle and the spray was made to impinge on a flat surface.

At the pump discharge, the agitation of the impeller was found to have reduced the oxygen in solution to 9.8 ppm at point C. The action of the nozzle dropped the oxygen content further to 8.9 ppm at point D and the impinging on a flat surface still further to 8.6 ppm at point E. This was considered to be a satisfactory reduction in oxygen content, and, therefore, in nitrogen content, since, at the same temperature, 63 F, saturation occurs at 9.5 ppm. Experience has shown that the system as put into operation has eliminated all trouble from supersaturation.

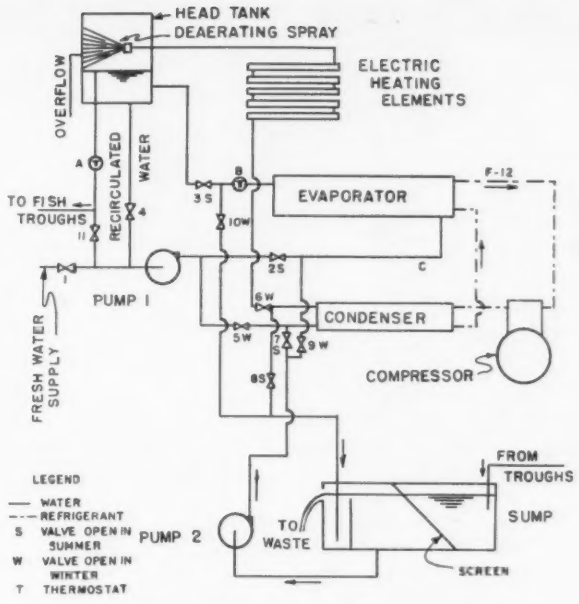


Fig. 2 Diagram of the arrangement of the parts and connections of the fish hatchery water conditioner

The tank provided for deaeration serves also as a head tank for the supply to the fish as well as a means of balancing the flows of fresh water and water recirculated within the conditioner, and of keeping the system filled at all times. By recirculating part of the water through the heat exchanger, greater velocities are obtained with better heat transfer. The repeated agitation by the pump and sprays lowers the gas content of the water even more than in the once-through tests. The tank is provided with an overflow pipe.

HEATING AND COOLING THE WATER

In Fig. 2, and additionally Figs. 3 and 4, there is shown the arrangement of equipment as installed and operated. Untreated water enters the system from the brook through valve 1 at a maximum rate of approximately 12 gpm. This, together with recirculated water coming through valve 4 from the head tank, is delivered by the pump, P_1, in summer through valve 2 to the evaporator to be cooled, or in winter through valve 5 to the condenser to be heated. The cooled water in summer discharges directly into the head tank through valve 3.

In winter, however, the water that has been warmed in the condenser flows through valve 6 to a bank of electric immersion heaters for supplementary heating when necessary, and then through the spray nozzles into the head tank. An amount of treated water equal to the fresh water entering by valve 1 from the brook now spills into the outlet pipe in the head tank and so goes to the fish, while the balance of the pump's capacity is returned through valve 4 to be recirculated.

The head on the supply main is only some 5 ft at no flow, and drops to a conspicuously low value with maximum flow to the fish. Therefore, valve 1 is kept open at all times that the conditioner is operating, and the relative proportions of fresh and recirculated water admitted to the pump are regulated by the adjusting valve 4. In the event of a power failure, the solenoid valve, No. 11, opens and allows brook water to by-pass the conditioner and go to the fish directly, thus insuring a continuous supply.

When the brook temperature is such that the conditioner is turned off, the solenoid valve also provides the required flow without the need

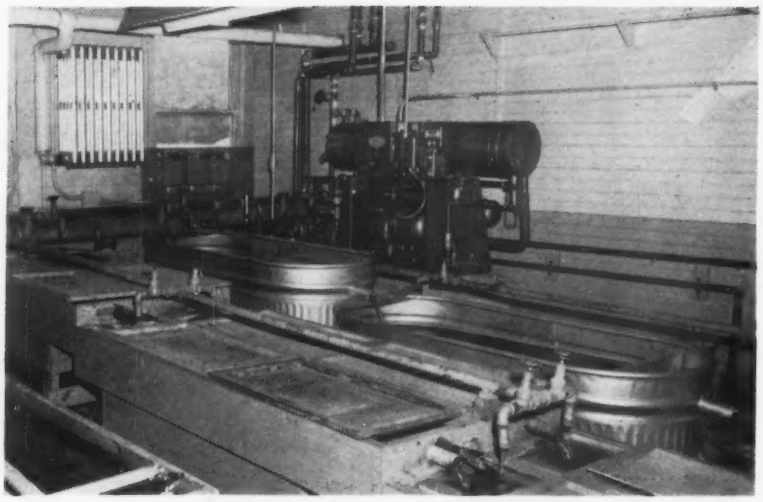
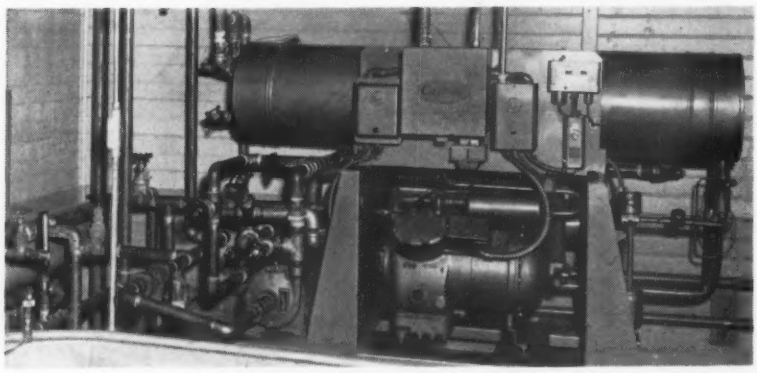


Fig. 3 A view of some hatchery troughs with the conditioner in the background

Fig. 4 Water cooler, showing the hermetic compressor, fresh water circulating pump, and the evaporator (water chiller). The head tank, with the sprays, is located on the floor above with the connections that are seen to go toward the ceiling



for changing any other valves. A float switch in the head tank detects any water shortage or failure and opens valve 11, even if there is no power failure.

Water that has been conditioned and supplied to the fish troughs is then discharged through a common channel to a sump under the floor. A screen stops the worst of the debris from the troughs as the water flows to the suction of the pump, P_2. When the troughs are being cleaned, the dirty water is discharged directly to the drain. In summer this cooled water is pumped through valve 7 to the condenser and back through valve 8 to the sump.

Since the capacity of pump 2 is greater than the usual flow from the troughs, provision is made, by the use of a weir and a baffle, to permit some of the water returning to the sump to flow over the baffle for recirculation, while an amount equal to that flowing from the troughs flows over the weir to the drain.

In winter, the flow from pump 2 is directed through valve 9 to the evaporator and back to the sump through valve 10. Thus, in summer the coolest available water is used for the condenser as a heat sink, and in winter the warmest water is used in the evaporator as a heat source.

On the basis of several assumptions, high coefficients of performance were predicted. Actual test data and results from operation during the winter of 1959-60 are as follows: With a flow into the conditioner of 91.2 lb per min (or 10.8 gpm) of brook water, the temperature rise was 18 F, from 34 to 52 F. This represents an addition of heat in the amount of 1641 Btu per min, supplied by the compressor. The power consumption of the compressor was 2.6 kw, equivalent to 148 Btu per min. Thus the Coefficient of Performance of the system, operating as a heat pump, was 1138/148, or 7.7.

Insufficient data were taken during the short period of operation of the equipment in the summer of 1959, after installation, to make reliable calculations of COP. However, since the conditions with summer operation are even more favorable than in winter, it seems reasonable to predict that the COP in summer as a refrigerator would be somewhat better than the usual COP as a heat pump minus one. Thus, the summer COP should be in the neighborhood of 7.

These coefficients show clearly how the energy supplied to the compressor is multiplied by the process of pumping heat from the water source in winter, and how considerable refrigeration is obtained at the expense of relatively little energy in the summer.

The controls included in the system are the usual ones. The compressor is safeguarded by pressure controls on both suction and discharge sides. The compressor cycles on and off according to the temperature of the conditioned water as sensed by thermostat A, Fig. 2. This thermostat was originally located at C just ahead of the evaporator. At C the thermostat would have functioned properly in summer but would have failed to control the conditioned water temperature in winter. A second thermostat, B, located at the outlet of the evaporator guards at all times against the danger of too much cooling.

The electric immersion heating elements are provided with manual switches so that they may be turned on when heating is required in excess of that supplied by the condenser. To protect the elements against overheating in the event of failure of water flow, thermostatic switches are provided in series with the manual switches.

Thus, water temperatures around 62 F are available in summer and around 55 F in winter. With the flow below the maximum of 12 gpm, the condensing unit cycles on and off, while the conditioned water temperature varies

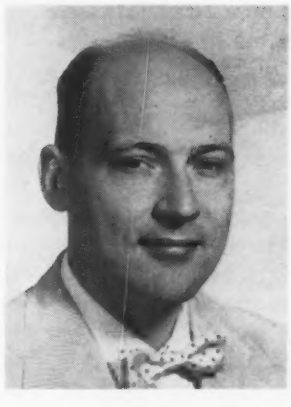
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Reaction of Refrigerant 12

with petroleum oils



H. O. SPAUSCHUS
Member ASHRAE



G. C. DODERER

The maximum operating temperature of a refrigeration compressor is often limited by chemical instability of the working fluid used in the system. This fluid is a solution or mixture of refrigerant and lubricant, and the present discussion is limited to combinations of dichlorodifluoromethane (Refrigerant 12) and petroleum oils. When tested independently, both refrigerant and oil are stable for the operating life of the equipment at temperatures well above those normally attained in refrigeration compressors.[1,2] However, it has been known for some years that Refrigerant 12 and petroleum oils will react at moderate temperatures, and that the rate of reaction is influenced by the nature of the oil and accelerators, such as steel, iron oxide, moisture, etc.

As many of the studies reported are of a comparative nature, the mechanism of the reaction between Refrigerant 12 and petroleum oil has not been defined clearly. Shaw and Brandon[3] heated Refrigerant 12 and two different oils in glass-lined steel bombs, observing that one solution darkened while the other showed no change in color. No chemical analyses were performed, nor did the authors discuss the refrigerant-oil reaction. Steinle[4] used a sealed tube test developed by Philipp and Tiffany[5] to compare the reactivity of a series of oils with Refrigerant 12. His results showed that the amount of darkening of the oil-refrigerant solution was related to the "resin" content of the oil. HCl and water were formed as products of the reaction and he suggested that tar or coke is formed as polymerization product of the oil. He pointed out, however, that his studies did not define the mechanism of the reaction.

. . . to gain a clearer understanding of the Refrigerant 12—petroleum oil reaction . . .

. . . to provide information about the mechanism and kinetics of the reactions . . .

. . . the decomposition of Refrigerant 12 is not stoichiometric with respect to chloride formation . . .

. . . presence of steel catalyzes the reactions . . .

. . . the probability of complicating side reactions places a definite upper limit on the temperature at which realistic tests can be conducted . . .

Elsey, Flowers and Kelley[6] also used color change as a measure of the extent of the refrigerant-oil reaction. The general mechanism they proposed is that chlorine, and, to some extent, fluorine are split from the refrigerant molecule to combine with hydrogen atoms coming from the hydrocarbon molecules comprising the oil. These authors also analyzed the contents of several tubes for chloride, showing that chloride formation increased with time. Williamitis[7] pointed out that the "relative Refrigerant 12 deterioration" showed large variations depending on the nature of the lubricant used. He did not state how deterioration was measured. Kvalnes and Parmelee[8] studied effects of type of oil, oil viscosity, oil additives, metals, moisture, antifreeze agents and cellulose on the refrigerant-oil reaction. Their results are reported as percent refrigerant decomposed, based on chloride analysis. The authors assumed stoichiometric decomposition of Refrigerants 12 and 22 to chloride.

Walker, Rosen and Levy[9] have reported effects of water, air, temperature, time and various metal

H. O. Spauschus is a Research Associate and G. C. Doderer is a Physicist at General Hospital Co. This paper has been prepared for presentation at the ASHRAE Semiannual Meeting, Chicago, Ill., February 13-16, 1961.

combinations on mixtures of Refrigerant 22 and three refrigerating oils. Tube contents were rated for color, viscosity change, sediment, wall deposits and copper plating as measures of the extent of reaction. No attempt was made to elucidate the course of the reactions or to identify such products.

The purpose of the present study was to gain a clearer understanding of the Refrigerant 12-petroleum oil reaction rather than to obtain more comparative data. A careful study of the reaction products formed at different temperatures and times provides information about the mechanism and kinetics of the reactions.

Materials and Experimental Procedures—Refrigerant 12 from a single cylinder was used for calibration of the mass spectrometer and for sealed tube experiments. Two different petroleum oils were studied: Oil A, a highly refined "water-white" oil, and Oil B, a medium refined naphthenic oil recovered from Gulf Coast crudes. Physical properties and carbon-type composition of each are given in Table I.

Known quantities of Refrigerant 12 and oil were sealed into glass combustion tubes (200 mm length, 8 mm ID, 10 mm OD) which were then heated, and the contents analyzed quantitatively. Details of the method of preparing the sealed tubes have been presented previously.[6, 9, 12] As well as charging in refrigerant and oil, a small strip of compressor valve steel weighing 0.048 gm was added to each tube prior to sealing. Precautions were taken to eliminate moisture and air from the oil and to control other variables, such as tube size and metal surface conditions. Instead of being placed directly in an oven, the sealed tubes were inserted into a stainless steel cylinder, which was partially filled with liquid Refrigerant 12 and then closed. This produced an excess pressure on the outside of the glass tubes, since the saturation pressure of pure Refrigerant 12 is greater than that of refrigerant-oil solutions. Consequently, the pressure differential between inside and outside the glass tubes was reduced greatly and glass tube breakage in the oven was eliminated.

TABLE I

PHYSICAL PROPERTIES AND CARBON-TYPE OF PETROLEUM OILS

	Oil A		Oil B		
Density, 20 C	0.8823		0.9149		
Refractive index, N_D^{20}	1.4780		1.4980		
Viscosity, cs at 20 C	108		92		
ssu at 100 F	192		156		
Molecular weight (Cryoscopic)	314		299		
Carbon Type	%C_P	%C_N	%C_P	%C_N	%C_A
n-d-M[10]	45	55	35	57	8
VGC - Ri[11]	45	55	36	56	8
Mean	45	55	35.5	56.5	8

After the heating period, the Refrigerant 12 was discharged from the stainless steel cylinder, the tubes removed and prepared for analysis. A sample tube was partially immersed in liquid nitrogen to freeze the refrigerant and lower internal pressure, reducing the possibility of premature breakage when a scratch was filed near the tip. The tip of the cold tube was inserted into the sampling fixture shown in Fig. 1 through a snugly fitting vacuum hose section, the tube being pushed in until the file scratch was even with the end of the copper tubing. Liquid nitrogen was again applied, and the sampling fixture was connected to the mass spectrometer through a calibrated gas handling system, as shown in Fig. 2. The gas system and sampling fixture were evacuated, until the thermocouple vacuum gauge indicated a pressure of less than ten micron Hg. The evacuation port was closed, liquid nitrogen removed, the sample tube grasped with a gloved hand, and sideways pressure exerted to break off the glass tip against the end of the copper tubing. Liquid nitrogen noncondensable gases expanded immediately. As the tube warmed, the refrigerant and other condensed gases gradually volatilized into the known volume system. After the tube had warmed to room temperature, the equilibrium pressure was read with a manometer. The amount of refrigerant originally charged into the tube usually produced a pressure between 250 and 300 mm Hg in the system volume of about 800 standard cc.

The large bulb, which constituted about 80% of the total expansion volume, was then closed off and gas evacuated from the rest of the system. The evacuation port was closed and gas was allowed to expand from the bulb to the mass spectrometer. Since there was some possibility of partial gas fractionation as the sample tube warmed to room temperature, gas for analysis was taken from the bulb, where mixing by diffusion could occur more readily than in the small diameter tubing.

Gas samples were analyzed using an analytical mass spectrometer. After manually recording hydrogen, the instrument was set to scan automatically upward from m/e 12, usually stopping at m/e 85, the base peak of Refrigerant 12. The sequence of running calibrations and samples was important. The first indication of Refrigerant 12 decomposition was the appearance of Refrigerant 22, $CHClF_2$, with base peak at m/e 51. Refrigerant 12 contributed less than 0.20%, relative to its base peak, to the 51 peak. Mass spectrometer cracking patterns of a gas normally show slight variations from one run to the next. Greatest variance found in the 51 peak during Refrigerant 12 calibrations indicated that Refrigerant 22 could be detected with certainty, when 0.10 standard cc or more was present in the entire gas sample from the tube.

The base peak of hydrogen chloride is at m/e 36. Refrigerant 12 contributed about 1.8% of its base peak to the 36 peak. A similar check of calibration pattern variations indicated 0.20 standard cc to be the detection limit for HCl.

Refrigerant 12 was run first to record its cracking pattern and establish its contributions at m/e 36 and 51. Experimental samples were run next. In order to realize the greatest sensitivity for Refrigerant 12 decomposition with the least interference from spectrometer background, the tubes for a day's analysis were arranged according to degree of fluid darkening and amount of sludge accumulation. Samples having little or no decomposition were run first while the spectrometer tube had negligible background. Tubes with the most decomposition were analyzed last, and scans to determine HCl background corrections were often necessary between sample runs.

After all sample patterns were recorded and another background determined, Refrigerants 12 and 22 and HCl were calibrated in that

order. Lastly, calibrations were performed for hydrogen and other gases detected in the samples. Using relative sensitivities determined from the gas calibrations and appropriate corrections for coincident peaks, percentage compositions of the gas samples were calculated. These percentages were then used with the measured volume of gas sample to calculate the amount of each component present, expressed as standard cc of gas.

RESULTS AND DISCUSSION

Mechanism of Refrigerant 12-Oil Reaction — Series of experiments were conducted at 175 and 200 C with tubes heated for periods of 7, 14 and 28 days. Results are summarized in Table II. In these experiments the ratio of weight refrigerant to weight oil was held nearly constant in the range 1.7 to 1.9. All results are the average of duplicate or triplicate experiments. Blanks in the table indicate absence of the gas.

The first gas to appear, and hence the most sensitive indicator for the reactions, was Refrigerant 22. As conditions became more severe (higher temperature, longer reaction time, less highly refined oil), new reaction products appeared in the order HCl, CO_2, CO, and CH_4. From these results, a mechanism for the Refrigerant 12-oil reaction has been postulated. At high temperatures Refrigerant 12 reacts selectively with "activated" molecules in the oil to form Refrigerant 22 and an unstable chlorinated hydrocarbon.

$$CCl_2F_2 + R\text{-}CH_2\text{-}CH_3 \longrightarrow RCH(Cl)\text{-}CH_3 + CHClF_2 \qquad (1)$$

An activated oil molecule, R-CH_2-CH_3, is visualized as differing from "normal" oil molecules either in structure of the carbon skeleton or because it contains non-hydrocarbon atoms such as phosphorous, nitrogen, oxygen or sulfur. Since more Refrigerant 22 is formed with the less highly refined Oil B, it is apparent that the concentration of these activated molecules can be reduced by acid washing or clay adsorption refining processes.

At high temperatures the chlorinated hydrocarbon dehydrohalogenates to produce HCl and an unsaturated hydrocarbon.

$$R\text{-}CH(Cl)\text{-}CH_3 \longrightarrow RCH=CH_2 + HCl \qquad (2)$$

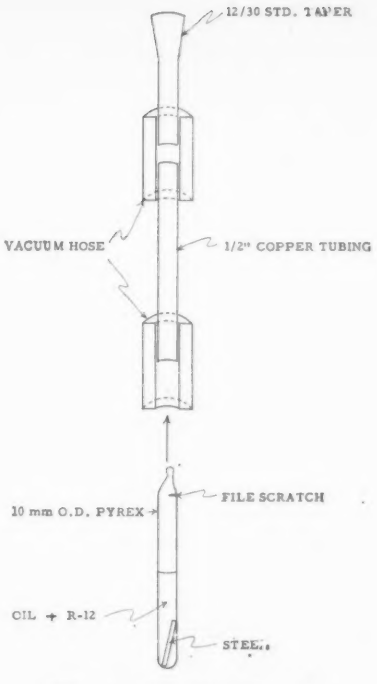
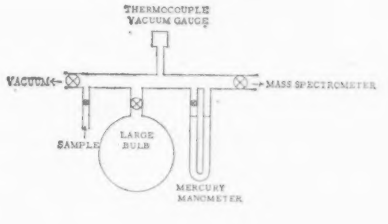


Fig. 1 Sampling fixture

Fig. 2 Calibrated gas handling system



HCl appears somewhat later than Refrigerant 22, indicating that the chlorinated hydrocarbon does not decompose immediately. Experimental data show that the concentration of halogenated oil is usually small, since approximate chloride balance exists between initial Refrigerant 12 and final 12 unreacted + 22 + HCl. For example, in a typical experiment the tube was charged with 1.485 gm of Refrigerant 12. After heating, the volumes of gases found were 160 cc of Refrigerant 12, 59 of Refrigerant 22 and 166 of HCl. The chloride balance is:

gm Cl from HCl	0.263
gm Cl from Refrigerant 22	0.094
gm Cl from Refrigerant 12	0.507
Total	0.864
gm Cl from original Refrigerant 12	0.870

When the concentration of unsaturated hydrocarbon molecules becomes sufficiently large, they polymerize to form tar or coke.

$$n\,RCH=CH_2 \longrightarrow (RCH\text{-}CH_2)_n \qquad (3)$$

HCl, as formed by reaction (2) can attack iron or steel present in the system, forming hydrogen and iron chloride.

$$2\,HCl + Fe \longrightarrow H_2 + FeCl_2$$

or

$$6\,HCl + 2Fe \longrightarrow 3H_2 + 2FeCl_3 \qquad (4)$$

Quantities of hydrogen are small, indicating this reaction is of minor magnitude for conditions studied. Microscopic examination of the steel strips, after high temperature tests, revealed a thin surface film in all cases where hydrogen was formed. Unfortunately, the film was too thin to confirm the presence of iron chlorides by X-ray diffraction analysis.

Previous studies of the thermal decomposition of Refrigerants 12 and 22 provide clues to the mechanism of CO_2 and CO formation observed for the more severe conditions. Norton[2] has shown that Refrigerant 12 is relatively stable up to temperatures as high as 500 C. In the presence of catalysts the decomposition rate is enhanced, but even with Fe_2O_3, the most effective catalyst, the decomposition rate is too low to account for the CO_2 found in our experiments. Refrigerant 22, however, decomposes at much lower temperatures with the formation of CO and CO_2. In the presence of effective catalysts, 1% of the Refrigerant 22 is decomposed per hr at 150 C. The overall reaction for experiments carried out in glass tubes is given by Norton as

$$CHClF_2 \xrightarrow[SiO_2]{Fe} CO_2 + CO + SiF_4 + 2HCl \qquad (5)$$

In our experiments, the partial pressure of Refrigerant 22 was relatively low and the iron surface covered with oil-refrigerant solution, thus retarding the rate of Refrigerant 22 thermal decomposition. In keeping with this hypothesis, our results reveal increased CO_2 formation with increasing temperature, time and Refrigerant 22 con-

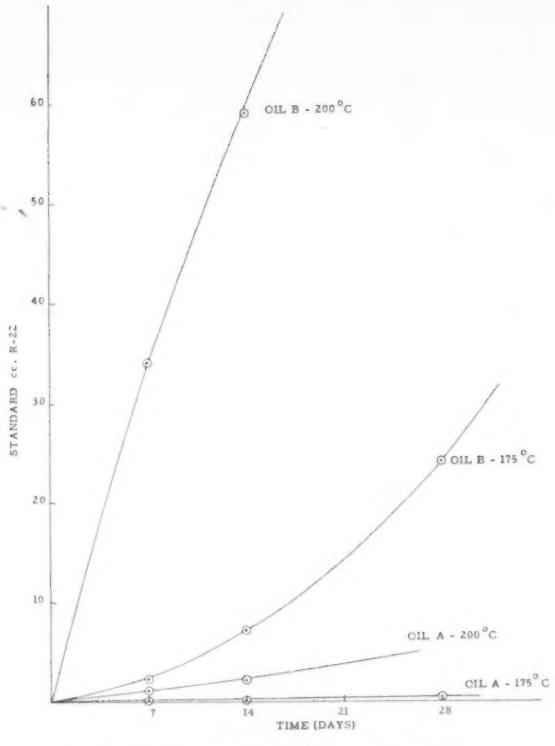


Fig. 3 Rate of Refrigerant 22 formation

centration. The increase in HCl/$CHClF_2$ ratio under severe conditions is further support for reaction (5).

Trace quantities of methane were detected under the most extreme reaction conditions studied, probably being produced by thermal cracking of the oil.

$$R - CH_3 - CH_3 \longrightarrow R' - CH_3 + CH_4 \quad (6)$$

In the postulated mechanism, Refrigerant 22 is formed by reaction (1) and some of it subsequently decomposes to form CO_2 and CO by reaction (5). Other studies[8,9] have shown that Refrigerant 22 will also react directly with oil, although not as readily as Refrigerant 12. It has not been possible to obtain information about this reaction in the present series of tests because of the complexity of the reactions preliminary to or concurrent with the Refrigerant 22 reaction. Substituting Refrigerant 22 for 12 in the sealed tubes would be a more direct and simpler method of studying this reaction.

Our experiments have established that large quantities of Refrigerant 22 are formed, thus proving that the decomposition of 12 is not stoichiometric with respect to chloride formation as suggested by Kvalnes and Parmelee. Although the reactions involved are complex, the quantity of chloride will usually provide a relative measure of the Refrigerant 12 decomposition rate.

TABLE II

STANDARD CC OF GASES FORMED BY REFRIGERANT 12-OIL REACTION

	175 C					
Oil	A			B		
Time (days)	7	14	28	7	14	28
HCl	—	—	—	3.4	12.2	55
CO_2	—	—	—	0.09	0.36	3
Refrigerant 22	0.07	0.10	0.23	2.3	7.2	24

	200 C			
Time (days)	7	14	7	14
CH_4	—	—	—	0.3
H_2	—	—	1.7	5.0
CO	—	—	—	1.3
HCl	0.3	0.9	69.	179.
CO_2	—	—	6.2	25.
Refrigerant 22	1.1	2.1	34.	59.

Effect of Refrigerant 12-Oil Ratio on the Reaction – A series of tests was conducted to see what effect the ratio of Refrigerant 12 to oil had on the type and quantity of reaction products. Results for both oils at 200 C, 14 days, are given in Table III.

For the combination Refrigerant 12-Oil B, which produces large quantities of reaction products, there are no significant changes in the type or quantity of gases formed in increasing the Refrigerant 12 to oil ratio by a factor of more than three. Variances in quantity of the individual gases are within the magnitude of error expected in these measurements. A possible exception is the small but regular increase in Refrigerant 22. These results imply that reaction (1) approaches zero order for oils containing a high concentration of "activated" molecules. The rate of reaction may be limited by the rate of diffusion of reactants or products through the liquid phase.

For Oil A, which produces small quantities of reaction products, Refrigerant 22 formation increases rapidly with increase in the Refrigerant 12 to oil ratio. An approximation calculation indicates the reaction for this combination is first order with respect to Refrigerant 12 concentration. The weight of Refrigerant 12 charged into the tubes provides a measure of the initial concentration, a, and it is assumed that one molecule of Refrigerant 12 has reacted for each molecule of 22 detected. The quantity reacted is designated as x. For a first order reaction

$$k = \frac{2.303}{t} \log \frac{a}{a - x}$$

and at constant time

$$\log \frac{a}{a - x} = \frac{kt}{2.303} = K$$

Results are summarized in Table IV.

The ratio $\frac{a}{a - x}$ is nearly constant for Refrigerant 12 with Oil A indicating a first order reaction as

TABLE III

EFFECT OF REFRIGERANT 12-OIL RATIO ON GASEOUS REACTION PRODUCTS AT 200 C

	14 Days					
Oil	A			B		
Refrigerant 12/Oil	1.16	1.70	3.13	1.02	1.88	3.70
CH_4	—	—	—	0.3	0.9	+
H_2	—	—	—	2.0	3.6	3.6
CO	—	—	—	1.4	2.5	1.7
HCl	—	—	0.15	151	164	159
CO_2	—	—	—	20	23	21
Refrigerant 22	0.42	0.90	2.3	48	55	59

a distinct possibility. For Oil B, the ratio $\frac{a}{a-x}$ decreases with increasing Refrigerant 12 concentration.

Rates of Reaction – Complexity of the Refrigerant 12-oil reactions makes it difficult, if not impossible, to interpret the results rigorously in terms of chemical kinetics. The system is heterogeneous and liquid phase concentrations at high temperatures can only be approximated. Presence of steel catalyzes the reactions. Some reaction products themselves are not stable and undergo further reactions.

Data for Oil B at 175 C, as given in Table II, were fitted to the first order rate equation using Refrigerant 22 quantities as a measure of the amount of Refrigerant 12 decomposed. The plot of log fraction reacted versus time was not linear. No calculations were made for Oil A-Refrigerant 12 reactions because the quantities of Refrigerant 22 found were extremely low, and small errors would be magnified many times in rate calculations.

In discussing the reaction mechanism, it was noted that Refrigerant 22 is the most sensitive indicator of Refrigerant 12 reaction. Thus, the Refrigerant 22 content, at any given time, provides a relative measure of the extent of the reaction. In Fig. 3, the amounts of Refrigerant 22 are plotted as a function of time for both oils at 175 and 200 C. Although some of the Refrigerant 22 undergoes further reactions, the curves in Fig. 3 provide a means of comparing the high temperature reactivity of different oils with Refrigerant 12 and illustrate important influences of the type of oil and temperature on the reactions. Oil A with Refrigerant 12 at 200 C is considerably more stable than Oil B with Refrigerant 12 at 175 C.

The high sensitivity of mass spectrometer analysis provides an advantage to this method as compared with previously published studies. In a period of days, differences in reactivity of various oils are readily distinguishable in tests at 175 C. At higher temperatures this time can be reduced even further. However, the probability of complicating side reactions places a definite upper limit on the temperature at which realistic tests can be conducted.

TABLE IV
REACTION RATE CALCULATIONS, 200 C

	Initial Concentration gm Refrigerant 12	Initial Concentration standard cc Refrigerant 12 (a)	Quantity Reacted (x)	$\frac{a}{a-x}$
Oil A	0.958	177.5	0.42	1.002
	1.587	294.1	0.90	1.003
	2.965	549.4	2.3	1.004
Oil B	0.962	178.3	48	1.37
	1.580	292.8	55	1.23
	3.247	601.7	59	1.11

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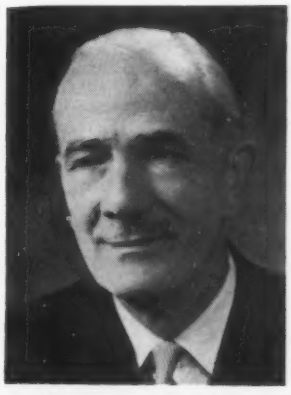
President Rayner to be Honored Guest at Welcome Luncheon

One of the outstanding special events of the ASHRAE Semiannual Meeting in Chicago will be the Welcome Luncheon scheduled for Monday, February 13.

Honored Guest will be President Leslie Rayner, of The Institution of Heating and Ventilating Engineers, London, England.

Master of Ceremonies for the occasion will be President J. C. Scott of the Illinois Chapter.

The induction of new officers, customarily a feature of ASHRAE Welcome Luncheons is, upon this occasion, being transferred to the Banquet on Tuesday evening, February 14.



LESLIE RAYNER
President
The Institution of Heating and Ventilating Engineers

As provided for by the Agreement for Consolidation, R. H. Tull will succeed Walter A. Grant as ASHRAE President, John Everetts, Jr., will become First Vice President. As official nominees, John Fox, Jr., is likely to be voted Second Vice President and John E. Dube is the probable Treasurer, succeeding himself to that office.



The Road Ahead

WALTER A. GRANT
President
ASHRAE

This occasion will be my last opportunity to speak to you as your President. For that reason, I should like to look back along the road we have travelled during the past seven months, and comment at the same time on what lies ahead.

In the President's Page for last July, I stressed the basic principle that the management of the Society has an obligation to advance the wishes of, and the best long-range interests of, the membership. And, as your President, I have considered it my most important responsibility to carry on the work so effectively started by my predecessors in office, and to strengthen the organization in the areas which have presented particularly difficult problems.

The first problem area involved the soundness of the Society's finances. During fiscal 1959-60, the Society operated in the red to the tune of more than $120,000. This deficit was due in part to lack of guide lines in budgeting the merged operation; to duplicate staff overhead; to non-recurring expenses arising out of the merger; and to failure to meet our income objectives from publications advertising and research contributions. Obviously, such losses could not be permitted to continue.

Accordingly, your officers and Board of Directors took those steps necessary to increase income and reduce expenses in order to bring our million dollar budget into balance. Unless the current business recession becomes even more severe, we have every reasonable expectation that we will achieve a black operating figure for the fiscal year end next June. And those of you who have studied the audited financial statement* already know that the balance sheet position of the Society is in excellent shape.

The second problem area related to serving adequately the important special interest groups within our three major membership fields of heating, refrigeration, and air conditioning and ventilation. As a result of actions taken at the Vancouver meeting, our Program Committee is making good progress toward helping these groups organize themselves into permanent working units to serve their members effectively. A tangible result of suggestions and requests from many members can be seen in the symposiums and forums at the Chicago meeting, covering frozen foods, transport refrigeration, medium temperature water heating, schoolhouses, domestic refrigerators and ventilation.

A third problem area involved policy determinations relating to our Society publications. During the last six months, Publications Committee, with the help of a special Publications Task Force, has come to grips with the important issues of sources of material, and quality and balance of technical content of our JOURNAL, Guide and Data Book, and Transactions. I view their recommendations as a significant forward step in further improving our already outstanding publications.

By now, you are all aware of the action taken by the Board to resolve the fourth problem, relating to our Reseach Laboratory in Cleveland.** I'm sure many of our members view the closing of the Laboratory with a keen sense of regret. Yet I believe it was commendable of the members of our Board to face up squarely to the realities of the situation, and recognize their responsibility to make a decision, unpleasant as it may have been, to secure the best long-range interests of the Society. The real challenge for the future is to organize and maintain Society leadership in research through the partnership of the many well-qualified educational and private research institutions in the country. I am confident that, in accepting this challenge, our Research and Technical Committee, with the help of many other devoted members, will establish the needed machinery and carry forward a vigorous program fully in keeping with our Society's achievements in the past.

The last problem area to which I directed your attention at Vancouver was the need to improve the administrative and committee organization of the Society. During my term of office, I have personally devoted much time to speeding up the internal ma-

* ASHRAE JOURNAL, December 1960, page 90.

** ASHRAE JOURNAL, January 1961, pages 54-56.

chinery, communications, and public relations of our Board of Directors and general and technical committees. The results of the Long Range Planning Committee study of the subject will be presented to the Board prior to the Denver meeting in June. Continued progress on the matter is important, for it has a direct bearing on our basic obligation to be responsive to the wishes and interests of the membership.

To summarize the events of the past seven months, I am satisfied that we have taken the first important steps toward recognizing, facing, and attacking our major problems. Much careful planning and hard work necessarily lie ahead. And more than ever, your national officers, Board of Directors, general and technical committees, and Headquarters Staff need not only your sympathetic understanding but also your strongest possible support.

It has been a memorable experience for me to serve you as your President. As I turn over the reins of office to my especially qualified successor, Bob Tull, I truly believe that the Society is better and stronger today than it has ever been in the past, due to the devoted efforts of so many hard working members in our chapters and on our general and technical committees. I should like to express my deep and sincere appreciation for the perfectly splendid cooperation and support I have received from all of you during my entire term of office.

BULLETINS AND CATALOGS

Coolers, Condensers. Selection information for industrial water coolers is presented in four-page Bulletin 108. Three different models are described, including centrifugal-fan blow-through, centrifugal-fan draw-through and tubeaxial fan blow-through units.

New fourteen-page Bulletin 143 is a revision of Bulletin 141, the evaporative condenser engineering manual. General theory and design of condensers is given, together with the basic refrigeration cycle. Selection information for evaporative condensers, summer and winter operations, capacity control, typical piping arrangements and system purging are detailed.
Baltimore Aircoil Company, Inc., P. O. Box 7322, Baltimore 27, Md.

Generator. Four-page, illustrated Bulletin 3562 explains how this sealed firebox generator delivers clean, steady combustion and eliminates stack draft. Advantages of pressurized dual-fuel (gas-oil) firing are detailed. Also discussed is how the package unit, with a range of 396,000 to 1,800,000 Btu/hr, provides fuel economy, low standby loss and reduced boiler height.
Petro, 3170 W. 106th St., Cleveland 11, Ohio.

Industrial Silencer Selection. A condensed design manual on methods for handling the problem of noise generated by gas flow devices used in industry, four-page Bulletin B-13 discusses acoustic criteria to be met. Design charts to allow proper selection of the type of silencer and its optimum size are included. Types covered include tubular, Centerbody-type tubular, twelve-in. pattern rectangular, sixty-in. pattern rectangular, straight splitter type and special silencers.
Silence, Inc., P. O. Box 21, Farmingdale, N. Y.

Flow Control System. For automatically fired hot water heat, components of this manufacturer's forced circulating flow control system are the subject of 12-page Catalog CC-660. Detailed are pressure tanks, high pressure water relief valves, flow control valves, water heaters, horizontal water circulators, air eliminators and automatic filling valves. Products are illustrated and specifications are tabulated.
H. A. Thrush and Company, Peru, Indiana.

Liquid Chiller Line. Described and illustrated in ten-page Bulletin 3926 are standard mechanical and electrical features of this line of hermetic packaged equipment. Tabulation of net rated capacity is presented together with charted cooler and condenser pressure drops. A step-by-step selection procedure is included to simplify use of the bulletin.

Presented as a guide to engineers is a typical set of engineering specifications for liquid chiller call-out. Tabulation of dimensional and physical data for both water-cooled and remote condenser models is correlated with outline type dimensional drawings, permitting determination of major system layout and installation information right from the bulletin. Typical elementary wiring diagrams for the Versare control panel and for auxiliaries also are included.
American Radiator & Standard Sanitary Corporation, Industrial Div, Detroit 32, Mich.

Heating Control. For regulating steam to a heating system in proportion to heat loss of the building, this heating control operates on a principle by which the steam supply pressure or vacuum is controlled by and synchronized to conditions in the return side of the heating system. Detailed in 36-page Bulletin 402-B are advantages, method of operation, application, specifications, heating system requirements, primary control valves, vacuum heating pumps, piping standards and application of the control with a divided heating system, remote area drainage and mechanical lift.

Extensive tabular data are supplemented with diagrammatic illustrations of various system arrangements.
Nash Engineering Company, South Norwalk, Conn.

Compressor Systems. Among the features of high pressure packaged compressor systems described and illustrated in eight-page Bulletin 189 are: balanced/opposed design to eliminate vibration, high performance compressor cylinders (pressures to 10,000 psig), crosshead-type construction, adaptability to synthetic lubricants and unitized assembly complete with motor driver, intercoolers and all accessories. Model HO is a portable,

(*Continued on page* 105)

Performance characteristics of

Air-Cooled Systems



BORIS KAUFMAN
Associate ASHRAE

Factors which influence the performance of air conditioning systems using air cooled condensers are analyzed.

A general chart for determining the capacity and operating conditions of an air cooled system at various indoor and outdoor temperatures is included.

Two basic disadvantages of air conditioning systems using air-cooled condensers are high condensing pressures and a decrease in capacity with increased ambient temperature. Difficulties resulting from high condensing pressures have been circumvented by designing compressors, condensers, receivers and relief devices to withstand the higher pressures associated with air-cooled units. Decrease in system capacity as the ambient temperature rises is a natural phenomenon which cannot be avoided.

An analysis of the performance of an air-cooled system under varying conditions indicates the necessity for extremely careful design. An increase in ambient temperature will lower condenser capacity and at the same time raise the inside wet bulb temperature, putting a greater load on the evaporator. The equipment will establish a new equilibrium condition with a fall-off in capacity which would depend upon the magnitude of the change of outdoor dry bulb and indoor wet bulb temperatures.

Effect of the evaporator capacity increase is to put an added load on the condenser when its own capacity is decreasing, thus materially raising the condensing temperature. An increasing ambient will continue this process until the equipment shuts down on compressor overload or high condensing pressure.

The increase in system capacity with ambient temperature rise due to the increase of the indoor wet bulb temperature, which occurs in water-cooled and, to a slightly lesser extent, in evaporative-cooled equipment, does not exist in air-cooled units.

It is standard practice to design air-cooled equipment with a temperature spread of from 20 to 30F between the condensing and ambient temperatures. Although a lower condensing temperature would raise the compressor capacity, it also would increase materially the size of the condenser coil or the amount of air that must be handled.

The exact relationship can be obtained by equating the heat lost by the coil,

$$q = UA \frac{(t_2 - t_1)}{\ln (t_c - t_1 / t_c - t_2)}$$

to that gained by the air, $q = 60\rho$ Cp cfm $(t_2 - t_1)$, solving for the leaving air temperature, t_2, and substituting this value in the second equation. The result is

$$q = \frac{60\rho \text{ Cp cfm } (t_c - t_1)}{\left[1 - e^{-\left(\frac{UA}{60\rho \text{ Cp cfm}}\right)}\right]}$$

from which it can be seen that the capacity of the coil is a linear function of the temperature spread and an exponential function of the coil area. Proportionate increases in the coil surface, other factors remaining the same, will result in continually diminishing gains in coil capacity.

In a practical application, if the coil area is augmented by increasing its face area, the velocity and, consequently, the heat transfer coefficient, U, will decrease, partially nullifying the effect of the greater surface. If the face area is kept constant and more rows are added, the heat transfer coefficient will not change, but the increase in pressure drop across the coil may necessitate a larger blower or motor.

Raising the air flow has a better effect, since, with the same coil, the heat transfer coefficient will increase, thus partially reducing the negative effect of the cfm term in parentheses. It should be mentioned that this increase in the heat transfer coefficient with a rise in velocity is non-linear and falls off as the velocity increases.

Change in condenser capacity, as shown in the final equation, is not equivalent to the change in system capacity. The compressor and evaporator coil, as well as the condenser, establish a balance point which determines the capacity of the unit.

To analyze the effect of a change in ambient temperature on system capacity, the effect that this change will have on the conditioned space wet bulb temperature

Boris Kaufman is Assistant Professor of Mechanical Engineering at the University of Idaho.

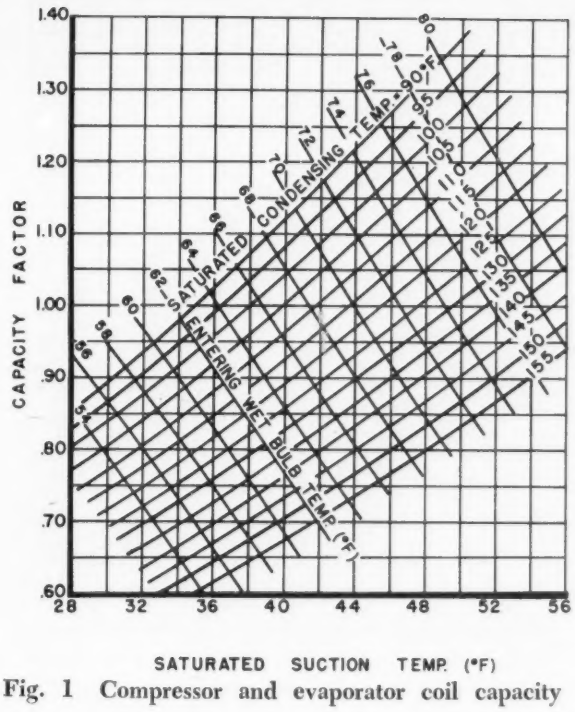


Fig. 1 Compressor and evaporator coil capacity

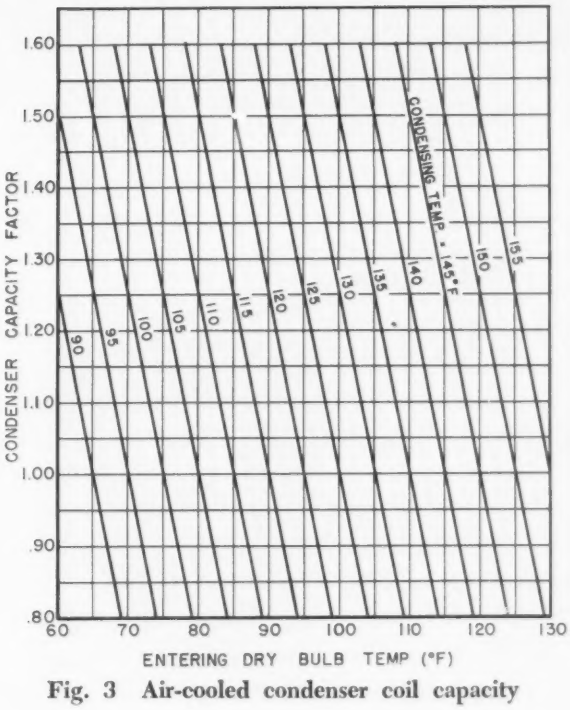
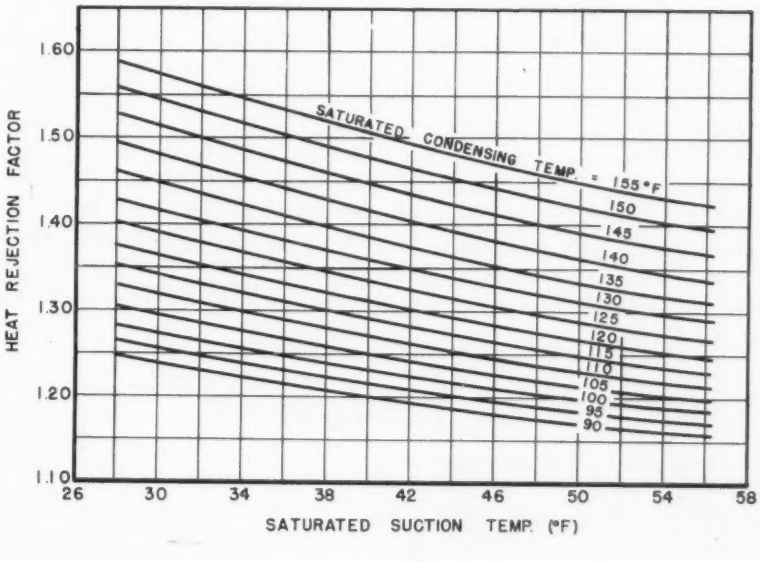


Fig. 3 Air-cooled condenser coil capacity

Fig. 2 Compressor heat rejection factor



must be known also. Unfortunately, it is not possible to generalize this change in indoor wet bulb temperatures as a function of the ambient, since too many variables are involved in each specific application, such as sun load, transient heat flow or fixed indoor loads. However, it is possible to analyze the performance of the air-cooled unit at specific indoor and outdoor temperatures.

This is accomplished by plotting the performance characteristics of the components involved and determining the various equilibrium conditions under which the equipment will operate. Typical curves for a compressor and evaporator are shown in Fig. 1, the heat rejection factor for the compressor in Fig. 2 and performance of the air-cooled condenser in Fig. 3. These curves are plotted in terms of a capacity factor, each component having nominal capacity under the following conditions:

Compressor — 40F saturated suction temperature, 105F saturated discharge temperature.

Evaporator coil—67F entering wet bulb temperature, 40F saturated suction temperature.

Condenser coil—95F entering dry bulb temperature, 120F saturated condensing temperature.

To determine performance curves for the system it is necessary to assume the suction and discharge temperature which fixes the system capacity as well as the wet bulb temperature of air entering the evaporator (Fig. 1). Knowing the suction and discharge temperatures enables determination of the heat rejection factor (Fig. 2); this factor times the system capacity yields the condenser capacity.

The temperature of the entering dry bulb to the condenser now can be found, since the condenser capacity and condensing temperature are known. These data, entering evaporator wet bulb temperature, system capacity and entering condenser dry bulb temperature, now fix a single point on Fig. 4, showing system equilibrium conditions.

By assuming an adequate number of operating conditions, the entire system chart can be drawn.* Fig. 4 also shows the saturated condensing temperature which indicates whether the system will oper-

* A more detailed analysis of this method can be found in: Simple Way to Analyze Performance of Compressor-Evaporator Combinations by William Goodman (Heating, Piping and Air Conditioning, Dec. 1937) and Graphical Analysis for Air Conditioning System Performance by Boris Kaufman (Refrigerating Engineering, July 1956).

NOMENCLATURE

Symbol	Item	Units
A	Coil surface area	ft^2
Cp	Specific heat of air at average temperature $\frac{t_1 + t_2}{2}$	B/#-F
cfm	Air flow	ft^3/min
q	Heat flow	Btu/hr
t_1	Temperature of air entering coil	F
t_2	Temperature of air leaving coil	F
t_c	Saturated condensing temperature	F
U	Overall coefficient of heat transfer	Btu/hr-ft^2-F
ρ	Density of air at average temperature $\frac{t_1 + t_2}{2}$	lb/ft^3

ate without exceeding the setting of the high pressure control.

The extent to which the compressor motor will be loaded must be determined from the manufacturer's data, knowing the suction and condensing temperatures. These temperatures can be found from Figs. 1 and 4. For example, a system operating at an ambient air temperature of 100 F and an evaporator wet bulb of 71 F will have a condensing temperature of 130 F and a capacity factor of 0.945 (Fig. 4). From the compressor data in Fig. 1, a condensing temperature of 130 F and a capacity factor of 0.945 indicate that the suction temperature will be 46.7 F.

A phenomenon peculiar to air-cooled systems is that of unit failure under light loads. During mild weather both the condenser and evaporator are under-loaded and, in essence, the condenser is too large for the system while the evaporator is too small. This results in low condensing and evaporator pressures, which often cause the expansion valve to starve the coil, reducing system capacity, or the low pressure control to stop the unit. There are various methods utilized to raise the condensing pressure when ambient temperature falls, either by reducing the amount of condenser air or backing liquid refrigerant into the coil to reduce effectively the condensing area. These methods have been described in detail by D. E. Kramer.*

The components used in determining Figs. 1 to 4 are typical of those presently used in the industry. However, it should be cautioned that the data should not be generalized greatly and, should information be desired for a set of components deviating from those shown, a new plot should be made.

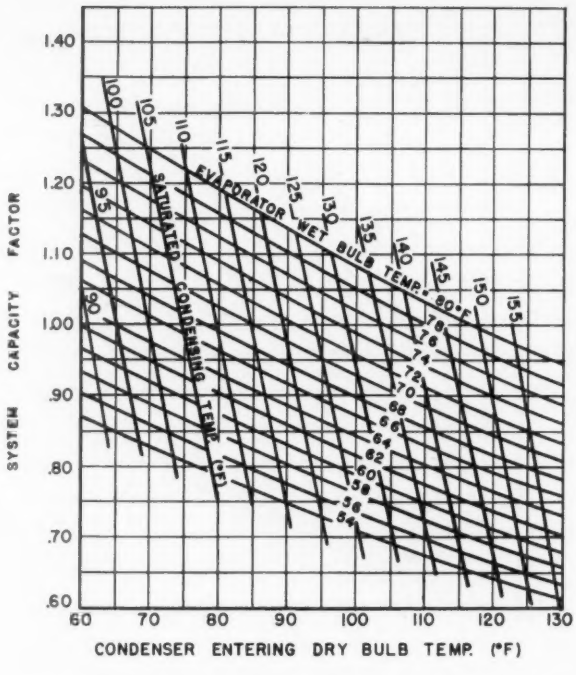


Fig. 4 System performance chart

* Refrigerant Control in Air-Cooled Condensers, D. E. Kramer (Refrigerating Engineering, July 1958).

It Will Be Water As The Refrigerant



Here under inspection is a model of the new heat-operated water chilling machines which Carrier Corporation is building for nuclear-powered submarines.

The cooler has few moving parts and is thus of low noise level, uses plain water as its refrigerant and is energized by steam from the submarine's atomic reactor. John F. Kooistra, Carrier sales manager for large equipment, is shown as he explains the unit's refrigeration cycle to Commander T. M. Johnston, inspector of material; Vice Admiral R. H. Rice (ret.) now affiliated with Research Corporation at Syracuse University and Commander T. R. Rhees, on the staff of Vice Admiral William F. Raborn.

Thermal Conductivity

of porous materials



MARK E. STEPHENSON, JR.



MELVIN MARK

The increasingly airborne aspect of our physical environment has emphasized the importance of reduced weight materials. These are often porous or cellular in construction. Greater use of such substances as plastics foams and honeycomb materials underscores this significantly. Fibrous insulations, textiles, granules and powders are all examples of materials which could be classified as cellular in the sense used here; that is, substances containing gaseous pores. For design purposes an important engineering property is the so-called thermal conductivity, especially since the application of these substances as insulation is common.

Here, a knowledge of the functional relationships between thermal conductivity, cell size and shape, apparent density, and material-property values for cellular materials is useful, but the general problem is fairly complex, and a simple relationship applicable to all cases is not available; qualitatively a better understanding of the relationships can be obtained by examining simplified models representing the materials and correlating conclusions obtained from these models with the limited available experimental data.

MECHANISMS OF HEAT TRANSFER

Thermal conductivity of a cellular material is a complex property, since all three mechanisms of heat transmission, that is, conduction, convection, and radiation, can play a role. Some heat is conducted through solid material and some through gas in pores. Convection also occurs in any gas pockets large enough to support circulation currents. Finally, radiation can travel from one surface to another in each cell, and some radiation may even travel through the solid if it is partially transparent to infra-red. It can be seen from this that "thermal conductivity" is not strictly a proper term. McAdams[1] recommends that results for cellular materials be expressed as conductances. However, since most of the available data is in terms of thermal conductivity, this will be used here, remembering that it means an overall apparent or effective thermal conductivity.

Since a cellular material possesses complex thermal patterns, it is natural that no simple single theory will suffice. The method of analysis used generally is adapted to the specific case being considered, certain less important factors being neglected compared to dominant ones, depending on permissible approximations for each case. However, since an approach suitable for one case is often unsuitable for another, assumptions involved in each analysis are of primary importance. Even for two substances composed of the same solid material in the same type of arrangement, a difference in cell size or density can change the relative importance of various mechanisms of heat transfer to the extent that the conductivity of one will fail to correlate with an analysis that fits the other.

METHODS OF ANALYSIS

In some applications, radiation and convection can be neglected in comparison to conduction through solid material and gaseous pores. Upper and lower limits for effective conductivity of a two-component system can be calculated. The upper limit occurs with materials

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Melvin Mark is Dean of Faculty, Lowell Technological Institute, and a consulting engineer; Mark E. Stephenson is a consulting engineer. This paper was prepared for presentation at the ASHRAE Semiannual meeting in Chicago, Illinois, February 13-16, 1961.

arranged in alternating plane layers parallel to the direction of heat flow. In this case

$$k_a = \phi k_s + (1 - \phi)\, k_g \qquad (1)$$

where k_a is the upper-limit effective conductivity of the cellular material, k_s and k_g are thermal conductivities of the solid and gas, and ϕ is the solid volume fraction. The lower limit, k_b, occurs with materials arranged in plane parallel layers perpendicular to the direction of heat flow. In this case

$$k_b = 1/[(\phi/k_s) + (1 - \phi)/k_g] \qquad (2)$$

Conductivity k of an actual cellular material might be expected to lie between k_a and k_b, the relative position between these limits depending on the physical arrangement of material. However, the ratio between k_a and k_b can be very great, of the order of ten to one or more, so that knowing only these limits is often of little practical help. An analysis of the problem for each specific type of geometrical arrangement of material considered is generally necessary.

Some relationships derived by Maxwell for electrical conductivity of mixed materials have been applied by Eucken[2] to thermal conductivity. For example, in the case of separated gaseous cells in a matrix of contingent solid material,

$$k = k_s \frac{1 - (1 - ak_g/k_s)\,(1 - \phi)}{1 + (a - 1)\,(1 - \phi)} \qquad (3)$$

where

$$a = 3/(2 + k_g/k_s) \qquad (4)$$

The derivation requires that $(1-\phi)$ be small compared to unity, so this relation applies only to fairly dense cellular materials, being inapplicable to cases (for example, many foamed plastics) where the gas occupies most of the volume.

For fibrous materials in which the arrangement of fibers can be assumed to be approximately random, Schuhmeister[3] applied the following reasoning: Since the arrangement is random, the average fiber will have equal components projected on three perpendicular axes. Therefore, since two axes are perpendicular to, and one axis is parallel to, the direction of heat flow, a weighted average of the previously discussed upper and

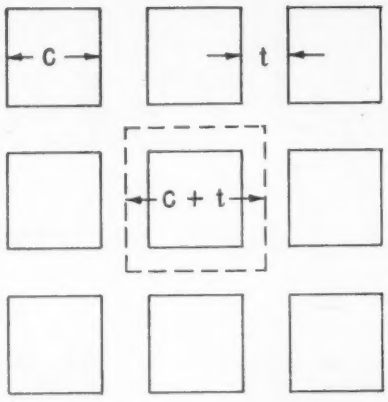


Fig. 1 Idealized cubical model of cellular material

lower limits, k_a and k_b, might be expected in the form

$$k = \frac{1}{3} k_a + \frac{2}{3} k_b \qquad (5)$$

Baxter[4] and Speakman and Chamberlain[5] managed to correlate some data on randomly arranged fibrous materials in this way, using numerical constants only slightly different from 1/3 and 2/3.

In the case of grains or powders, various physical models and the resulting analytical expressions have been proposed, for example, Deissler and Eian[6] and Schumann and Voss.[7] Deissler and Boegli[8] utilized a model consisting of spheres in packed cubical array and obtained a relationship for the effective conductivity k in terms of any given values of k_s and k_g. This gives a predicted position of k between k_a and k_b. Results check well with experimental data which Deissler and Boegli obtained on a number of various powders. This solution is for only one value of ϕ, $\phi = 0.52$. However, the contribution is valuable in that it takes into account, by a numerical relaxation technique, the fact that the heat flow lines are not unidirectional in a nonhomogenous substance.

The foregoing relationships express effective conductivity as a function of solid volume fraction. In fact, McAdams[1] states, in general, that "For nonhomogeneous solids the apparent thermal conductivity at a given temperature is a function of the apparent or bulk density ρ_a." Equations (1) and (2), as well as relationships such as Equation (3), predict an increase in k with increasing ϕ, as $dk/d\phi$ is positive for $k_s > k_g$. Since the apparent density ρ_a increases with solid volume fraction ϕ, these relationships predict an increase in k with increasing ρ_a. Therefore, for the same general type of physical arrangement of material, it may be expected that the k of an actual cellular substance might increase as ρ_a increases. This trend is reflected in many experimental results. For example, Harrington[9] presents data on the effective conductivity of a foamed plastics which shows $dk/d\rho_a$ positive everywhere in the range of ρ_a considered. In fact, Jacob[10] states, without qualification or statement of assumptions involved, that the effective conductivity of a loose or porous body "increases more than linearly with the apparent density."

All the foregoing considerations would appear to lead to the conclusions that the effective conductivity of a cellular material (a) can be correlated as a function of apparent density, and (b) will increase with increasing apparent density. However, these two conclusions are not valid in general. The analyses discussed in the preceding are all based on the general approach of considering only pure conduction, neglecting any effects of radiation or convection. Presence of appreciable radiation or convection changes the situation considerably. Here importance of cell size should be emphasized. As used here, the term "cell size" refers to the average dimension of gas-filled pores. Apparent density is not a singular specification of the state of a cellular material, since it is possible to have more small cells, or fewer large cells, at the same overall apparent density. Gas cell size and apparent density must be considered as two independent variables, effective conductivity being a function of these two variables for any given type of substance.

The influence of cell size on radiation heat transfer is illustrated by the following simplified case. If two large black-body parallel flat plates, 1 and 2, perpendicular to the direction of heat flow, are at absolute temperatures T_1 and T_2, respectively, with $T_1 > T_2$, then heat will be transferred between them by radiation at the rate per unit area

$$q = \sigma (T_1^4 - T_2^4) \quad (6)$$

where σ is the Stefan-Boltzmann constant. Now assume a thin third black-body plate, at an intermediate temperature T_1, interposed between the other two. Then

$$q = \sigma (T_3^4 - T_1^4) = \sigma (T_1^4 - T_2^4) \quad (7)$$

and as $T_3 > T_1 > T_2$, it is clear that the heat transfer has been reduced even though the interposed plate is of high emissivity and of negligible thickness or very high conductivity. Clearly, a larger number of cells per unit thickness through a material presents a greater impedance to radiation, as heat must be absorbed and reradiated more times.

Nusselt[11] made an analysis for cellular materials, assuming convection negligible and material arranged in alternate plane layers of solid and gas perpendicular to direction of heat flow. Although these simplifications limit the applicability of the results, the approach is of interest since it includes the effects of radiation. When transformed into the same parameters and notation as used here, the result is

$$k = 1/\left\{ (\phi/k_s) + \frac{1}{[k_g/(1-\phi)] + (4\sigma T_{avg}^3/n)} \right\} \quad (8)$$

where T_{avg} is the average absolute temperature and n is the number of cells per unit length in the direction of heat flow. It will be noted that if radiation were neglected, Equation (8) reduces to Equation (2) as it should, since the assumptions involved are then the same. Quantity n is significant in determining effects of radiation, and will be encountered again in the next section when certain general qualitative parameters are discussed.

Convection is influenced by pore size, since the effects of gas circulation due to natural convection will be greater in a larger cell. As used here, the phrase "heat transfer by convection" means any heat transmission by the gas over and above the lower limiting asymptotic value represented by pure conduction through stagnant gas. Allcut[12], who made conductivity measurements on many types of cellular materials, calculated percentage of heat transmitted by convection in his samples, but used a method which requires neglect of radiation. A significant parameter in convection is cell size c. This parameter also will be discussed in the next section.

An interesting study of fibrous materials, specifically glass fiber, was made by Verschoor and Greebler.[13] They concluded that an almost negligibly small percentage of heat transfer takes place by solid conduction, the majority taking place by gas conduction, convection, and radiation. The relation assumed by Verschoor and Greebler can be obtained by taking Equation (2) and neglecting ϕ/k_s, so that

$$k = k_g/(1-\phi), \quad (9)$$

replacing this k_g with an equivalent sum of the effects of gas conduction, convection, and radiation, and adding a correction term to account for what they found to be the "small amount of heat transfer due to the irregular contacts between the fibers." This contrasts with the work of Schuhmeister, whose Equation (5) takes into account the through-conduction described by Equation (1). However, there are two reasons why longitudinal through-conduction along strands of solid fiber, included in Equation (1), may be suppressed. One is that it is possible that fiber glass has very poor thermal transfer at fiber contacts due to the microscopic properties of the strands. The other reason is the influence of fiber orientation. Sheets or bats of fibrous insulation generally have a preferred orientation of the strands in the plane of the sheet, due to pressing during forming. This nonrandom strand orientation would make such materials much better approximated by Equation (2) than by Equation (1).

Fibrous insulating materials provide a good example of substances in which radiation and convection cannot be neglected. These materials often show effective conductivity decreasing with increasing apparent density, as was true over the entire range of apparent density considered by Verschoor and Greebler. However, other data shows effective conductivity of various fibrous materials, textiles, and so on, increasing with increasing apparent density. Foamed plastics show similar behavior; an increase in apparent density can produce either an increase or decrease in effective conductivity, depending on conditions. In fact, effective conductivity can go up or down with no change in apparent density. Additional independent variable cell size is here of paramount importance. Data is presented in the next section indicating that not only is apparent density alone an insufficient specification, but that it is often of less importance than the influence of cell size.

QUALITATIVE PARAMETERS

It can be seen from the foregoing discussion that a number of approaches to the general problem are possible. In order to guide the analysis of any specific case, certain qualitative parameters can be developed which aid in determining the importance of various modes of heat transmission, especially how each mode will vary with changes in cell size and apparent density.

Consider a substance made up of a large number of randomly arranged cells (an example would be foamed plastics). An idealized model of such a material can be taken to be as shown in Fig. 1. Cells are given as cubes of side c, with wall thickness t between cells. By considering a typical block such as enclosed by the dashed lines, it follows that the density ratio will be

$$\rho_a/\rho_s = 1 - [1/(1 + t/c)^2] \quad (10)$$

and the fraction of cross-sectional area for solid conduction will be

$$f = 1 - [1/(1 + t/c)^2] \quad (11)$$

where ρ_a is the apparent overall density and ρ_s is the density of the solid material. In the following, ρ_s will be assumed constant. Clearly, ratio t/c, density ρ_a, and fraction representing solid conducting area f, all increase or decrease together.

Any excess of conductivity of material over the conductivity of gas in the pores must be due to additional contributions of solid

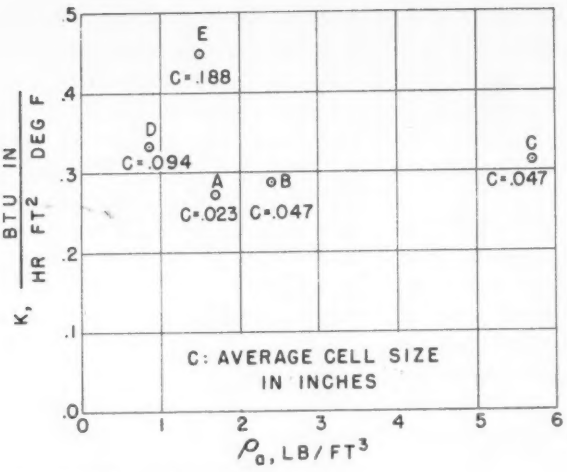


Fig. 2 Thermal conductivity versus apparent density for polystyrene foam at 70 F

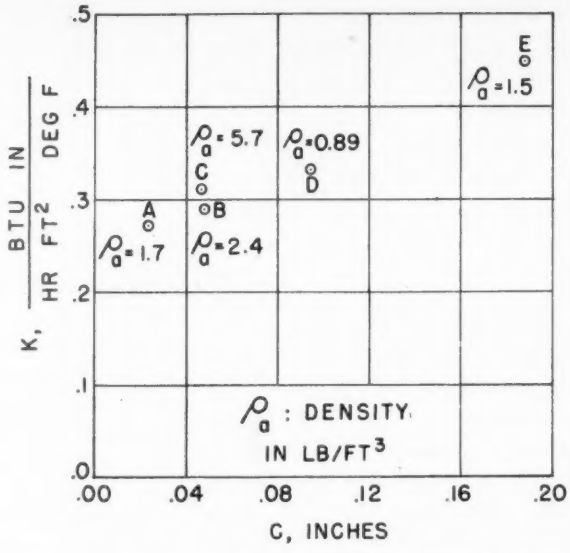


Fig. 3 Thermal conductivity versus average cell size for polystyrene foam at 70 F

conduction, radiation, and convection.

Heat transmitted by solid conduction is a function of f. As shown previously, this increases with t/c. Instead of t/c, the ratio ρ_a/ρ_s can be considered, as both increase or decrease together.

Heat transmitted by radiation is a function of the reciprocal of the number of cells encountered per unit length, 1/n. This is because radiant heat flow is lowered when radiation cannot travel directly across a space, but instead must be absorbed and reradiated by a number of intervening walls as discussed earlier. The general phenomenon might be called a "cascade effect," and 1/n represents the freedom from cascade effect, or "directness" of heat flow.

Heat transmitted by convection is a function of two variables, cell size c, and 1/n. Larger cells can support more rapid circulating currents, while smaller cells restrict them and promote a stagnant condition. The cascade effect also exists for convection, since a stagnant film exists next to a solid boundary, so that each solid-gas interface creates a resistance to thermal transfer.

Effective conductivity can therefore be expected to increase with three parameters: ρ_a/ρ_s (representing solid conduction), 1/n (representing directness), and c (representing circulation). Of course, the conductivity is not linearly proportional to the above parameters, as these occur in the heat-transfer equations in complex way. For example, below a certain cell size (about 1/16 in.), circulation is almost nonexistent. At least qualitatively, however, the conductivity should increase as the cited parameters increase.

From Fig. 1

$$n\,(c + t) = 1 \qquad (12)$$

where n is the number of cells encountered per unit length in the direction of heat flow.

Equation (12) can be rewritten in the form

$$1/n = c\,(1 + t/c) \qquad (13)$$

If $(1 + t/c)$ is eliminated between Equation (10) and (13), there results

$$\frac{1}{n} = c\,[1/(1 - \rho_a/\rho_s)^{1/3}] \qquad (14)$$

Equation (14) provides a simple relationship between the directness, circulation, and solid conduction parameters and emphasizes that conductivity is not a function of apparent density only, cell size being another important factor. This concept is supported by data obtained by McIntire and Kennedy [14]. They discussed improvement in insulating ability of polystyrene foam on going from a larger cell size, such as was made during World War II, to a smaller cell size similar to foams in use today. The data on conductivity given by McIntire and Kennedy are plotted in Fig. 2 as a function of density and Fig. 3 as a function of cell size. It can be seen that in the range of variables included in this data the conductivity is a stronger function of cell size than of density, since a single curve could be fitted better to the points of Fig. 3 than to those of Fig. 2.

Parameters of Equation (14) can be used to analyze some specific cases. First, consider the case where ρ_a is held constant and c is increased. Then solid conduction is constant, circulation is increased, and so by Equation (14) the directness must also increase. Conductivity will therefore increase. An experimental check is given by points A and E of Fig. 2.

Next consider the case where c is held constant and ρ_a is increased. Then circulation is constant, the solid conduction is increased, and so by Equation (14) directness must also increase. Conductivity will therefore increase. An experimental check is given by points B and C of Fig. 3.

Finally, consider the case where t is held constant and ρ_a is increased. If ρ_a is increased, the ratio t/c is increased, but t is constant, so c is decreased. Equation (14) or (12) then shows that 1/n is decreased. Therefore convection and radiation are decreased, but solid conduction is increased. From this it is not immediately clear whether over-all conductivity is increased or decreased. However, at quite low values of ρ_a, where the cell size is large, convection and radiation are present to a great extent, while solid conduction is small. Hence an increase

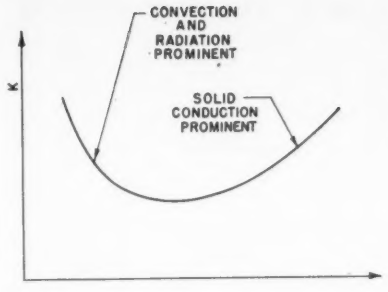


Fig. 4 General variation of thermal conductivity versus apparent density for fibrous materials

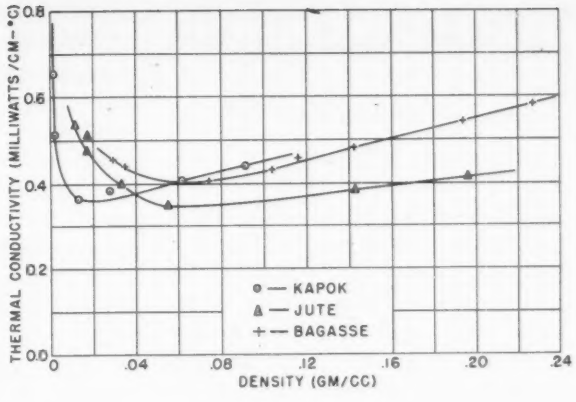


Fig. 5 Thermal conductivity (milliwatt/cm deg C) versus apparent density (gm/cm³) for various fibrous materials

in ρ_a, which would decrease convection and radiation (although increasing solid conduction), would be decreasing the primary mechanism of heat flow. The conducductivity could, therefore, be expected to decrease. Conversely, at quite high values of ρ_a, where cell size is small, the major contribution to heat transmission is by conduction, so that a reduction in this through a lowering of ρ_a could be expected to decrease the conductivity. Therefore, it might be presumed that a curve such as shown in Fig. 4 would result, with a minimum conductivity at some optimum value of density.

It would be difficult to obtain experimental data on foams corresponding exactly to constant t. However, consider the fibrous insulating materials such as mineral wool. Increasing the density is often achieved not by varying the diam of the strands, but simply by compressing the material. Such substances, of course, depart widely from a cubical model of cellular materials. However, some data, obtained by Finck,[15] is shown in Fig. 5. The predicted behavior of thermal conductivity versus density checks with these results. This effect has also been noted by Wilkes[16] and more recently by Thigpen and Short.[26] As an application of this, if it is desired to obtain the max insulating effect from a fibrous material within a given available thickness of insulation, material should be used at its "optimum" density. This is often well above the density at which such fibrous insulating materials are commonly sold. In fact, some fibrous materials can be quite dense and still retain excellent insulating properties. Certain types of glass fiber insulation, for example, appear to have their "optimum" density approximately in the range of between ten and twenty lb per cu ft.

A minimum conductivity at some "optimum" density may also be expected to exist in the case of some foamed plastics, since the previous reasoning may well apply, at least qualitatively, even if the case is not one of exactly constant wall thickness. Some recently reported data support this conclusion; a curve of conductivity versus density given by Redman[17] is shown in Fig. 6.

INFLUENCE OF PROPERTY VALUES

Thermal conductivity of solid material will, of course, influence overall heat transmission. Even more important than thermal conductivity, however, may be the radiation characteristics of the solid material involved. Some heat is radiated directly across each cell from one side to the other. The emissivity of surfaces is therefore important. Also, some radiant heat may pass directly through thin cell walls. Radiant heat transfer will be reduced if both emissivity and transmissivity can be reduced, for example, by adding aluminum powder fill to a plastics foam. Such an addition would, of course, raise the thermal conductivity of solid material and so increase to some extent heat transmitted by solid conduction. The net effect may well be an improvement in insulating properties, however, if the fraction of cross-sectional area occupied by the solid material is fairly small, as is often the case.

The value of thermal conductivity of the solid material generally can be expected to be important when the solid conduction parameter is relatively large, while the emissivity of the solid material can be expected to be important when the directness parameter is relatively large.

Properties of gas filling the cell pores also influence over-all heat transmission. This gas need not necessarily be air. If it is of high molecular weight, its conductivity will generally be low. Its free-convection heat transfer would be somewhat greater than air, largely because its density is greater, if space were sufficient to permit circulation. However, since convection is negligible in small cell spaces, the net effect is generally a lower heat transmission than with air. Considerable interest in insulation of this type has arisen in connection with construction of commercial refrigerators. With insulation of lower thermal conductivity, thickness can be reduced and food storage area made larger for the same external refrigerator dimensions. One problem, however, is diffusion of heavy gas out of, and air into, the insulation. A low-permeability "skin" must surround and seal insulation of this type.

It might be expected that percentage improvement in insulating effect through use of a heavy gas would be greatest when the circulation, directness, and solid conduction parameters are all small; that is, when heat transfer is primarily by gas conduction. In the case of a fibrous material of constant strand diam the following reasoning applies. At high density, heat transfer, largely through stagnant gas conduction, will be reduced, but at low density where large pores can support some circulation, heavy gas will provide greater heat transfer than air. Therefore, it seems reasonable to predict that with a heavy gas "optimum" density for a fibrous mate-

rial will be shifted toward somewhat higher values of apparent density.

MEAN-FREE-PATH EFFECT

Another factor connected with cell size is utilization of molecular "mean-free-path effect," making it possible to lower thermal conductivity of material below the thermal conductivity of the gas in the pores. Since the early work of Smoluchowski[18] and others, this has been a subject of interest. Its application to the effect of cell size on effective conductivity can best be introduced as follows:

First-approximation analysis of gaseous heat conduction by kinetic theory shows that thermal conductivity of a gas is independent of its pressure. But this conclusion cannot hold true down to a complete vacuum, since absence of all gas molecules precludes any conduction. At quite low pressures, where the mean free path of gas molecules becomes comparable to the geometrical dimension of space enclosing the gas, the above simple analysis (involving statistical assumptions requiring large numbers of molecules, colliding much more often with each other than with the walls) breaks down. According to Jakob,[10] such pressures are of the order of about 0.05 mm Hg for enclosing-space dimensions commonly encountered. Further analysis shows that at extremely low pressures, approaching a pure vacuum, thermal conductivity is linearly proportional to pressure, approaching zero conductivity at zero density. Glass vacuum bottles, for example, are in this range.

A plot of thermal conductivity k, versus pressure p, for a gas would appear as shown schematically in Fig. 7. However, as mentioned before, thermal conductivity actually begins to drop off at pressures where mean free path is comparable to enclosing-space dimensions. The abscissa p in Fig. 7 is therefore not the proper independent variable; thermal conductivity should be plotted as a function of the ratio of mean free path, λ, to enclosing-space dimension, c, that is, λ/c. This has the form of a Knudsen number, Kn. Plotting the thermal conductivity against 1/Kn, that is c/λ, gives a curve of the same shape but emphasizes the fact that k is actually a function of the ratio c/λ. If cell size, c, of a cellular material is of the same order of magnitude as the mean free path, λ, possessed by air at sea-level pressure, then thermal conductivity of the material will enter the region in which it can be decreased below that of still air even though pressure is not reduced. But this requires extremely small pores, of the order of millionths of an inch. However, a few materials have been produced which do enter the range of this mean free path effect, and possess thermal conductivities less than that of still air. Examples are "Santocel" brand silica aerogel[19,20] powdered insulation, and "Min-K" brand molded insulation. Recent contributions to the study of this effect include Deissler and Boegli[8] for powders, and Verschoor and Greebler[13] for fibrous aggregates.

HONEYCOMB MATERIALS

A honeycomb material consists of a hexagonal cell array of core substance separating two facing sheets or skins. An analysis of the apparent conductivity of honeycomb materials has been made by Dunkle, Gier and Bevans.[21] They conclude that thermal resistance of the air cell is so large compared to that of solid material that it may be neglected, and the situation treated as two purely conductive resistances in series, that of the solid material in the core and that of the bond (which cements core to skin). Dunkle, Gier and Bevans succeeded in correlating experimental results for a large number of honeycomb specimens based on this approach. However, material property values, as well as the solid volume fraction, are here of considerable importance. Their samples were all of aluminum, which has a high conductivity. Neglecting heat transfer through the air cell is therefore a good approximation, as solid conduction naturally predominates. However, many honeycombs are made of laminated, resin-impregnated paper or glass materials, with much lower conductivities. In addition, these substances often have surfaces of high emissivity, quite contrary to the shiny surfaces so often associated with aluminum, so that radiation

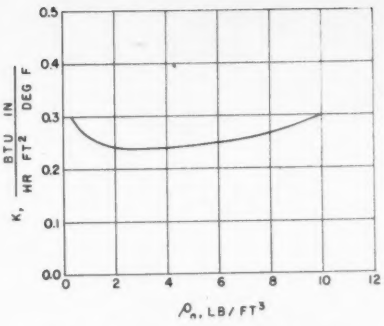


Fig. 6 Thermal conductivity versus apparent density for expandable polystyrene

across the cell cannot be readily neglected. The correlation of Dunkle, Gier and Bevans cannot, therefore, be applied accurately to honeycombs of this type.

Mark[22] suggests an approximate approach for honeycomb materials in general. He writes for the effective conductivity of the core,

$$k = xbh/2 + (1 - x)\, k_s \qquad (15)$$

where h is the film coefficient for the honeycomb cell, k_s is the thermal conductivity of the solid material, b is the core thickness, and x is that fraction of the area that is gas. The first term in Equation (15) represents heat transfer through the gas cell part of the honeycomb, which is accomplished by convection currents, gas conduction, and radiation. Since there is a resistance to heat flow at each solid-gas interface bounding the cell, the term is composed of the sum of two individual surface resistances 1/h, or 2/h. It is multiplied by x to account for the proportional part of the area affected.

The value of h in Equation (15) is a function of core thickness b, cell size, temperature pattern, and cell wall properties. The value of h could be expected to lie between two limiting values. The lower limit would be the h-value equivalent to conductivity of a gas space equal to core thickness (with no radiation or convection present). The upper limit would be the equivalent value for a gas space infinite in two dimensions[23] but of thickness equal to the core thickness, convection and radiation being present. Mark suggests that, as a first approximation, a simple means of these two limits be used, and presents experimental data on

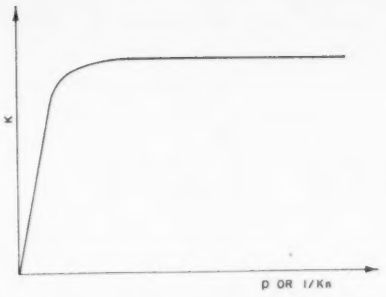


Fig. 7 General variation of thermal conductivity versus reciprocal of Knudsen number for a gas

plastics honeycombs showing good correlation with this approach.

Considering independent variable cell size, heat transfer by both convection and radiation is reduced when cell size is reduced. The reduction in convection is due to the small space which limits gas circulation. The reduction in radiation can be seen by examining the radiation equation.

$$q = \sigma F (T_1^4 - T_2^4) \qquad (16)$$

where F is a factor depending on the emissivities of surfaces involved and the geometrical configuration or shape. A honeycomb is basically different from foamed, fibrous, or granulated materials in that only one cell exists from one side to the other. The "directness" for radiation as previously defined; i.e., 1/n, is therefore the same for all honeycombs. However, the radiation is influenced by the geometrical aspect ratio of cells (ratio of cell thickness to equivalent cell diam). For the gas cell of a honeycomb core, F depends upon some equivalent cell diam, cell length, and emissivity of cell walls. Specifically, F is proportional to the equivalent cell diam to cell length ratio,[1] cell length being the core thickness. Consequently, reducing the cell size reduces F, indicating a reduction in heat transferred by radiation across the core.

If the cell size is reduced by increasing the number of cells rather than by increasing thickness of the cell walls, and if x in Equation (15) is not decreased appreciably, then as the cell size decreases the conductivity of a honeycomb core could be expected to decrease. This also has been predicted elsewhere.[24] However, as the cell size is decreased, x in Equation (15) may decrease appreciably. Then reducing the cell size would be equivalent to replacing conduction through gas with conduction through the solid core material. Since the conductivity of solid-core material is normally greater than that of gas, conductivity of the core might increase; in other words, the increase in heat transferred by conduction might more than balance the reduction in radiation and convection. Some data exist which substantiate this.[21,25] As neither extensive test data nor exactly appropriate theoretical equations are available at the present time, it is not possible to draw a general conclusion on the effect of decreasing honeycomb cell size on effective conductivity.

Comparing the honeycomb core with a material such as foamed plastics, it could be expected that the honeycomb would not be as good an insulator, since the plastics foam is made up of a large number of quite small air cells (i.e., less directness and almost no circulation). Consequently, heat is transferred largely by conduction and radiation through the still gas and the plastics walls in the case of the foamed plastics, whereas convection, as well as direct radiation and often greater solid conduction, may be present to a larger extent in the honeycomb core.

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NOMENCLATURE

- a = factor defined by Equation (4), dimensionless
- b = core thickness of honeycomb material, in.
- c = cell size, in.
- F = factor in radiation equation, dimensionless
- h = film coefficient of skin in honeycomb cell, Btu/hr ft^2 deg F
- k = thermal conductivity of cellular material, Btu in./hr ft^2 deg F
- k_a = upper-limit thermal conductivity of two-component mixture, Btu in./hr ft^2 deg F
- k_b = lower-limit thermal conductivity of two-component mixture, Btu in./hr ft^2 deg F
- k_g = thermal conductivity of gas, Btu in./hr ft^2 deg F
- k_s = thermal conductivity of solid material, Btu in./hr ft^2 deg F
- n = number of cells per unit length parallel to heat flow, in.$^{-1}$
- p = pressure, mm Hg abs
- q = heat flow rate per unit area, Btu/hr ft^2
- t = wall thickness, in.
- T_{av} = average temperature in cellular material, deg R
- T_i = temperature of intermediate flat plate, deg R
- T_1 = temperature of warmer flat plate, deg R
- T_2 = temperature of cooler flat plate, deg R
- x = fraction of honeycomb area occupied by gas, dimensionless
- λ = mean free path of gas molecules, in.
- ρ_a = apparent over-all density, pcf
- ρ_s = density of solid material, pcf
- σ = Stefan-Boltzmann constant, Btu/hr ft^2 (deg R)^4
- ϕ = solid volume fraction, dimensionless

Predicting

Air Friction Pressure Loss

in shallow ducts



C. P. LENTZ



U. NAKANO

Prediction of air friction pressure loss in straight shallow ducts of rectangular cross-section is important in the design of jacketed cold storage rooms[12] and refrigerated trucks and railway cars,[1,3,10,13] especially those using forced air circulation. In design of jacketed storage rooms, a basic requirement is uniform distribution of refrigerated air through a shallow jacket around the periphery of the room.

Friction pressure losses much larger or smaller than those predicted in designing the system may cause uneven air flow distribution and thus affect temperature and relative humidity in the room.[12] The problem of air distribution through shallow duct spaces is even more important in refrigerated transport vehicles where space is limited and operating conditions are severe.

In some applications, ducts made of plywood or rough insulating materials, as little as ½ in. deep, and carrying air at velocities as low as 100 or as high as 1000 fpm, may be required and relatively small differences in friction pressure loss may be significant.

C. P. Lentz and U. Nakano are with the Engineering and Development Sect, Div of Applied Biology, National Research Council of Canada.
Issued as N.R.C. No. 6155.

Prediction of friction pressure loss in shallow ducts of rectangular cross-section may also be important in other refrigeration and air conditioning applications where space for ducts is limited or uniform air distribution in shallow spaces is necessary.

For jacketed cold storage rooms, refrigerated trucks, railway cars . . .

. . . prediction of the effects of differences in relative surface roughness, appears to be in error . . .

. . . for ducts of extreme dimensions, hydraulic diameters are open to question . . .

. . . caution should be used in predicting friction factors for materials not tested previously . . .

Although extensive information is available on air friction pressure loss in straight ducts, little is directly applicable under the conditions here outlined, and there is an uncertainty about the magnitude of errors that would result from extending the use of existing information to cover these conditions. This doubt arises mainly from difficulty in predicting the effect of different kinds of duct surface roughness on friction pressure loss, and also from lack of knowledge of the validity of using the hydraulic diameter (4 × area over perimeter) parameter in extending data obtained with cylindrical ducts or rectangular ducts of low aspect (width to depth) ratio to ducts of much greater aspect ratio.

Friction pressure loss for turbulent flow has been found to be a function of relative surface roughness (usually expressed as the ratio of the height of the roughness projections or "absolute roughness" to the hydraulic diameter), a factor depending on duct size as well as the shape, size, density and arrangement of surface roughness projections or indentations.[2,6,7,16,18] Except in the case of complete geometric similarity, however, prediction of the effect of differences in relative roughness appears to be subject to error. Friction pressure loss is also dependent on the Reynolds number characteristic of the flow (N_R), and, in practice, the effects of relative roughness and Reynolds number are combined in a coefficient designated the friction

factor. No measurements of friction factor appear to have been made for plywood or thermal insulating materials in board form.

Hydraulic diameter has been shown experimentally to be a valid parameter for comparing rectangular ducts of limited aspect ratio, in the turbulent flow range, with cylindrical ducts (for which most of the theoretical background on friction pressure loss has been developed), but its use is open to question for ducts of more extreme dimensions.[8,9,11,17] In the laminar flow range special equations have been derived for friction pressure loss in rectangular ducts.[14]

Purpose of the work described in this report was to obtain reliable information on friction pressure loss in shallow rectangular ducts of large aspect ratio, constructed of plywood and several thermal insulations in board form having different forms of roughness, under flow conditions of interest in the design of jacketed cold storages and refrigerated transport vehicles.

APPARATUS AND PROCEDURE

Essentially, the test set-up consisted of a rigidly supported test duct and apparatus to blow air through it at a measured and controlled rate (Fig. 1). The square-edged orifice plate and associated delivery tube used for measurement and control of air flow were constructed in accordance with the recommendations of the ASME.[4] Accuracy of control and measurement were improved by a baffled plenum chamber between the fan and the entrance of the delivery tube. Use of a second plenum chamber between the delivery tube and the test duct facilitated changing of delivery tubes and test ducts as required for various test conditions. Overall length of the ducts (39 ft) was dictated by the dimensions of the laboratory, but was found to be sufficient. A linear pressure loss between the first and last static pressure stations in all the tests showed that the eight-ft entrance section was adequate.

Pressures were measured with a micromanometer giving an accuracy of 0.001 in. of water. Pitot tubes of standard proportions[5] were used in measuring static pressure in the test ducts, and in calibrating the orifice plates. Orifice plate flanges had static pressure taps of standard design[4] for measuring the pressure difference across the orifice. Temperature and barometric pressure were also recorded during tests.

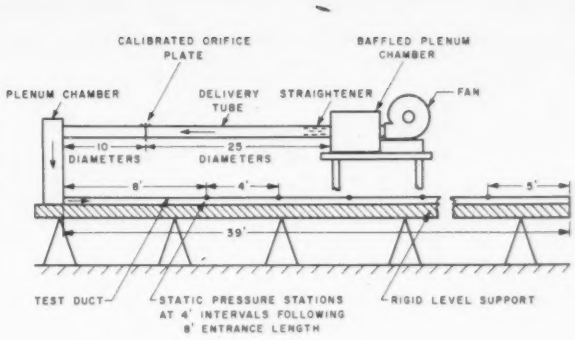
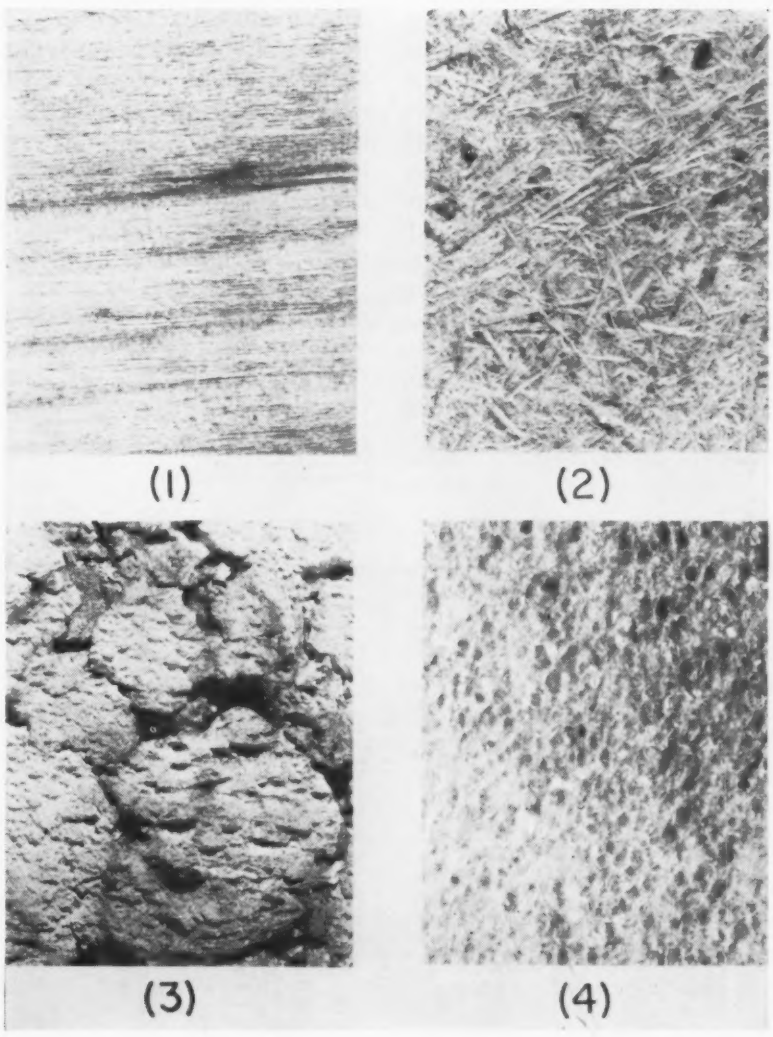


Fig. 1 Schematic sketch of apparatus for measurement of air friction pressure loss in shallow ducts

Size of the test ducts and the materials from which they were made were selected to provide basic information that would be readily applicable in commercial practice. Aspect ratio effect was studied in a series of fir plywood ducts 14½ in. wide and 4, 3, 2, 1 and ½ in. in depth (inside dimensions). The plywood was ⅜

Fig. 2 Photographs showing the form of surface roughness of the four materials tested (magnification a little less than 4x, estimated absolute roughness in parentheses following the name of the material): plywood (0.002 to 0.003 in.), wood fiberboard (0.010 to 0.015 in.), corkboard (0.10 to 0.15 in.) and foamed plastics board (0.020 to 0.035 in.)



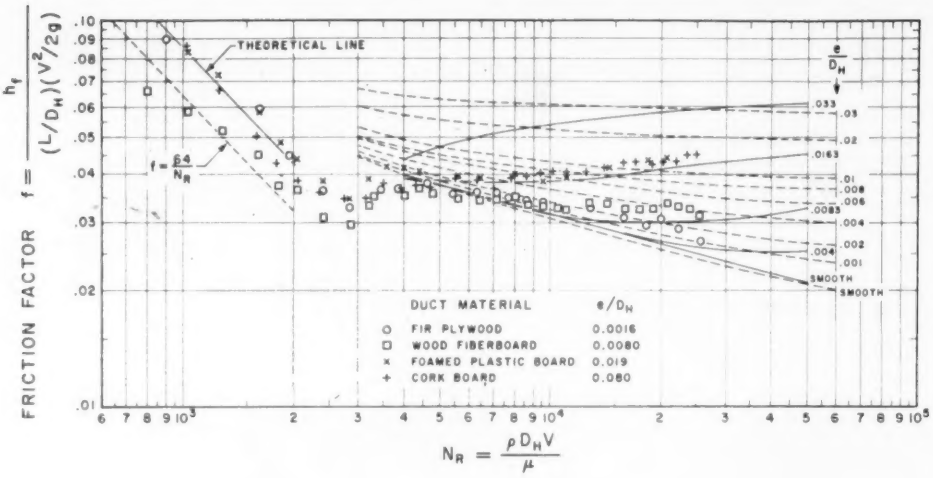


Fig. 3 Friction factors for fir plywood ducts of different aspect ratio

Relative roughness is approximately equal for the one-in. deep ducts. Dashed lines represent a summary of friction factor data covering a wide range of relative roughness for commercial pipes, as given by Moody (15). The theoretical lines in the laminar flow range are based on an equation for rentangular ducts given by McAdams (14).

in. thick exterior grade Sylvaply* with the "good" side inward and the grain parallel to the direction of air flow.

This gave a range of aspect ratios extending to 29:1, well beyond 8:1, a value which has been given as an upper limit for the reliable use of the hydraulic diameter parameter.[8,9] Ducts less than ½ in. in depth were not used because variation in the dimensions as constructed (1/32 to 1/16 in.) would have been large relative to the depth.

Measurements made with two additional ducts 1 in. in depth, 7¼ in. and 22½ in. wide, respectively, provided comparison of ducts of equal (or nearly equal) aspect ratio, but different dimensions, and made it possible to separate probable effects of aspect ratio and depth for shallow ducts. Measurements were made also with an 8 x 8-in. duct to facilitate comparison of the results of this study with published data on circular pipes and rectangular ducts of less extreme dimensions.

The effect of different kinds of roughness (Fig. 2) was studied with 14½ x 1-in. ducts made of wood fiberboard (Ten-Test*), corkboard,** and foamed plastics insulation (Styrofoam 33***) in sawed board form, in addition to the plywood ducts previously described. The fiberboard, corkboard, and foamed plastics ducts were encased in ⅜-in. thick plywood for mechanical strength. Transverse reinforcing was used on all ducts to limit bulging at high rates of air flow. As shown in Fig. 2, the plywood had a relatively smooth, uniform, striated form of roughness.

Surface of the fiberboard was much rougher than that of the plywood, and this roughness was of a random, fibrous nature. The corkboard had larger projections and indentations than any of the other materials, but felt smooth to the touch. Roughness of the foamed plastics was formed by the sharply cut edges of the plastics cells. Height of the roughness projections or indentations (absolute roughness) of the different materials as estimated with the aid of a microscope is given with Fig. 2.

Measurements were made over much of the range of velocities likely to be of commercial interest, with minimum velocities (50 to 200 fpm, depending on duct size and friction factor) being determined by the least friction pressure loss that could be measured with reasonable accuracy.

Results are expressed in the form of a relation between friction factor and Reynolds number (9, p. 69-72; 17, p. 205 and 215), taking into account the effect of relative roughness $\left(\frac{e}{D_H}\right.$, where e is the absolute roughness, and D_H is

* Plywood Manufacturers Association of British Columbia.

* International Panel Boards Ltd.
** Armstrong Cork Co.
*** Dow Chemical Co.

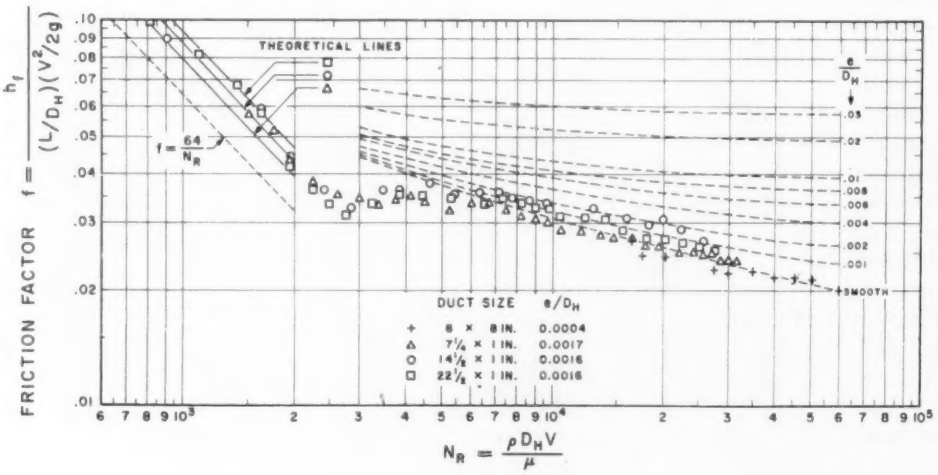


Fig. 5 Friction factors for fir plywood, wood fiberboard, corkboard, and foamed plastics board ducts 14½ x 1 in. in size

Dashed lines represent a summary of friction factor data covering a wide range of relative roughness for commercial pipes, as given by Moody (15). Light solid lines in the turbulent zone are from the results of Nikuradse (16). The theoretical line in the laminar range is based on an equation for rectangular ducts given by McAdams (14).

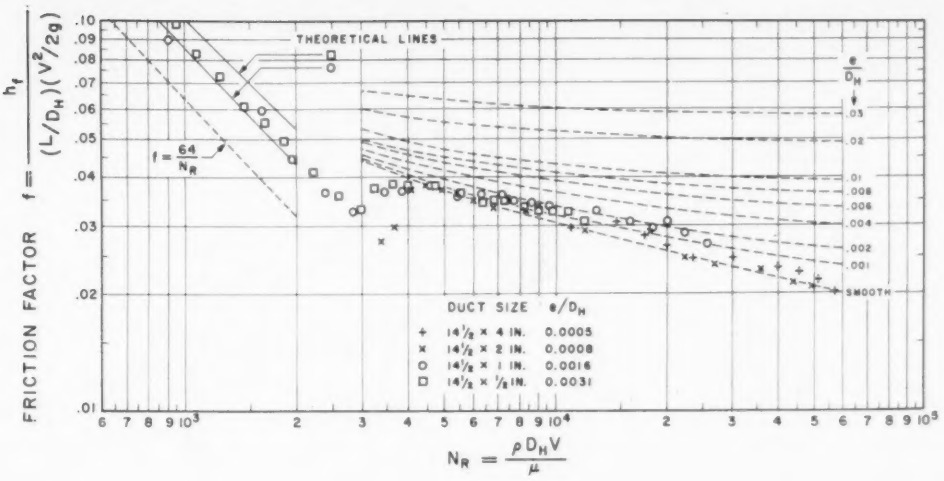


Fig. 4 Friction factors for 14½-in. wide fir plywood ducts of different depths

Relative roughness is approximately inversely proportional to depth. Dashed lines represent a summary of friction factor data covering a wide range of relative roughness for commercial pipes, as given by Moody (15). The theoretical lines in the laminar flow range are based on an equation for rectangular ducts given by McAdams (14).

the hydraulic diameter). The dimensionless friction factor, f, is calculated from the equation:

$$h_f = f \frac{L}{D_H} \cdot \frac{V^2}{2g}$$

where

h_f = friction pressure loss, ft of the fluid flowing
L = length of duct, ft
V = velocity of air flow, fps
g = acceleration due to gravity, fps/sec
D_H = hydraulic diameter = $\frac{4 \times \text{area of cross-section}}{\text{perimeter of cross-section}}$, ft

The Reynolds number, N_R, is calculated from:

$$N_R = \frac{\rho D_H V}{\mu}$$

where

ρ = density of the fluid, lb per cu ft
μ = absolute viscosity of the fluid, lb per ft-sec

RESULTS AND DISCUSSION

Variation of the aspect ratio of plywood ducts from 1:1 to 29:1 apparently affected the friction factor in the turbulent range of flow conditions to an appreciable extent (Figs. 3 and 4; Fig. 3 separates the effect of aspect ratio from other possible effects, since results are presented for a series of ducts of essentially the same thickness, relative roughness, and hydraulic diameter, and Fig. 4 extends the range of aspect ratios covered). Friction factor for the 14½ x 1-in. duct is higher than might be expected, without apparent explanation. A second 14½ x 1-in. duct of similar construction gave essentially the same results.

Although the range of aspect ratios covered in the laminar zone did not affect the friction factor demonstrably, the results are in closer agreement with the theoretical equation given by McAdams for rectangular ducts[14] than with the equation for cylindrical pipes,

$$f = \frac{64}{N_R}.$$

Comparison of Figs. 3 and 4 indicates that relative roughness, with absolute roughness constant, had little effect on friction factor with plywood ducts and confirms conclusions drawn from Fig. 3 regarding the effect of aspect ratio. The 14½ x ½-in. and 22½ x 1-in. ducts, for example, with approximately equal aspect ratios but different degrees of relative roughness, differed little in friction factor. A similar comparison may be made for the 14½ x 2 and 7¼ x 1-in. ducts.

Friction factors for the different materials, tested under comparable conditions, are given in Fig. 5, together with Moody's[15] summary of friction factors for commercial pipes (dashed lines) and Nikuradse's[16] results for artificially roughened pipes (light solid lines). Except for the fir plywood, results of the present investigation seem to agree more closely with the work of Nikuradse than with

(*Continued on page 122*)

Table I

Comparison of Experimental and Estimated Friction Factors for 14½ x 1-in. Ducts

Notes: 1. Estimated values for laminar flow are from (1) $f = 64/N_R$ (circular pipes) and a theoretical equation for rectangular ducts given by McAdams (14), for turbulent flow from data given by Moody (15), and Nikuradse (16), using the measured values of roughness (maxima) of Fig. 2.

2. Differences between experimental and estimated friction factors are given in parentheses.

Duct material and Reynolds number (N_R)	Friction factor, f: Experimental	(1) $f = 64/N_R$ (2) McAdams	Moody	Nikuradse
Fir plywood				
1,500	0.057	(1) 0.043 (—25%)	—	—
		(2) 0.057 (0%)	—	—
5,000	0.037	—	0.039 (+ 11%)	0.037 (0%)
20,000	0.029	—	0.029 (0%)	0.026 (—10%)
Wood fiberboard				
1,500	0.045	(1) 0.043 (— 5%)	—	—
		(2) 0.057 (+27%)	—	—
5,000	0.035	—	0.046 (+ 31%)	0.037 (+ 6%)
20,000	0.033	—	0.039 (+ 18%)	0.030 (— 9%)
Corkboard				
1,500	0.052	(1) 0.043 (—17%)	—	—
		(2) 0.057 (+10%)	—	—
5,000	0.038	—	0.090* (+137%)	—
20,000	0.043	—	0.087* (+102%)	—
Foamed plastics board				
1,500	0.060	(1) 0.043 (—28%)	—	—
		(2) 0.057 (— 5%)	—	—
5,000	0.040	—	0.055 (+ 38%)	0.041 (+ 2%)
20,000	0.043	—	0.050 (+ 16%)	0.046 (+ 7%)

* Extrapolation.

ASHRAE CHAPTER AND REGIONAL BOUNDARIES

REGION I

CHAPTER	LOCATION
1. Boston	Boston, Mass.
2. Western Massachusetts	Springfield, Mass.
3. Rhode Island	Providence, R. I.
4. Northern Connecticut	Hartford, Conn.
5. Southern Connecticut	New Haven, Conn.
6. Long Island	Garden City, L. I., N. Y.
7. North Jersey	Newark, N. J.
8. New York	New York, N. Y.
9. Northeastern New York	Albany, N. Y.
10. Central New York	Syracuse, N. Y.
11. Rochester	Rochester, N. Y.
12. Niagara Frontier	Buffalo, N. Y.

REGION II Canada

CHAPTER	LOCATION
13. Chapitre de la Ville de Quebec	Quebec City, Que
14. Montreal	Montreal, Ont.
15. Ottawa Valley	Ottawa, Ont.
16. Ontario	Toronto, Ont.
17. Manitoba	Winnipeg, Man.
18. Southern Alberta	Calgary, Alta.
19. Northern Alberta	Edmonton, Alta.
37. Niagara Peninsula	Hamilton, Ont.

REGION III

CHAPTER	LOCATION
21. Philadelphia	Philadelphia, Pa.
22. Central Pennsylvania	Harrisburg, Pa.
23. Johnstown	Johnstown, Pa.
24. Pittsburgh	Pittsburgh, Pa.
25. Baltimore	Baltimore, Md.
26. National Capitol	Washington, D. C.
27. Hampton-Roads	Norfolk, Va.
28. Richmond	Richmond, Va.

REGION IV

CHAPTER	LOCATION
29. North Piedmont	Greensboro, N. C.
30. South Piedmont	Charlotte, N. C.
31. South Carolina	Columbia, N. C.
32. Atlanta	Atlanta, Ga.
33. Savannah	Savannah, Ga.
34. Jacksonville	Jacksonville, Fla.
35. Florida West Coast	Tampa, Fla.
36. South Florida	Miami, Fla.

REGION V

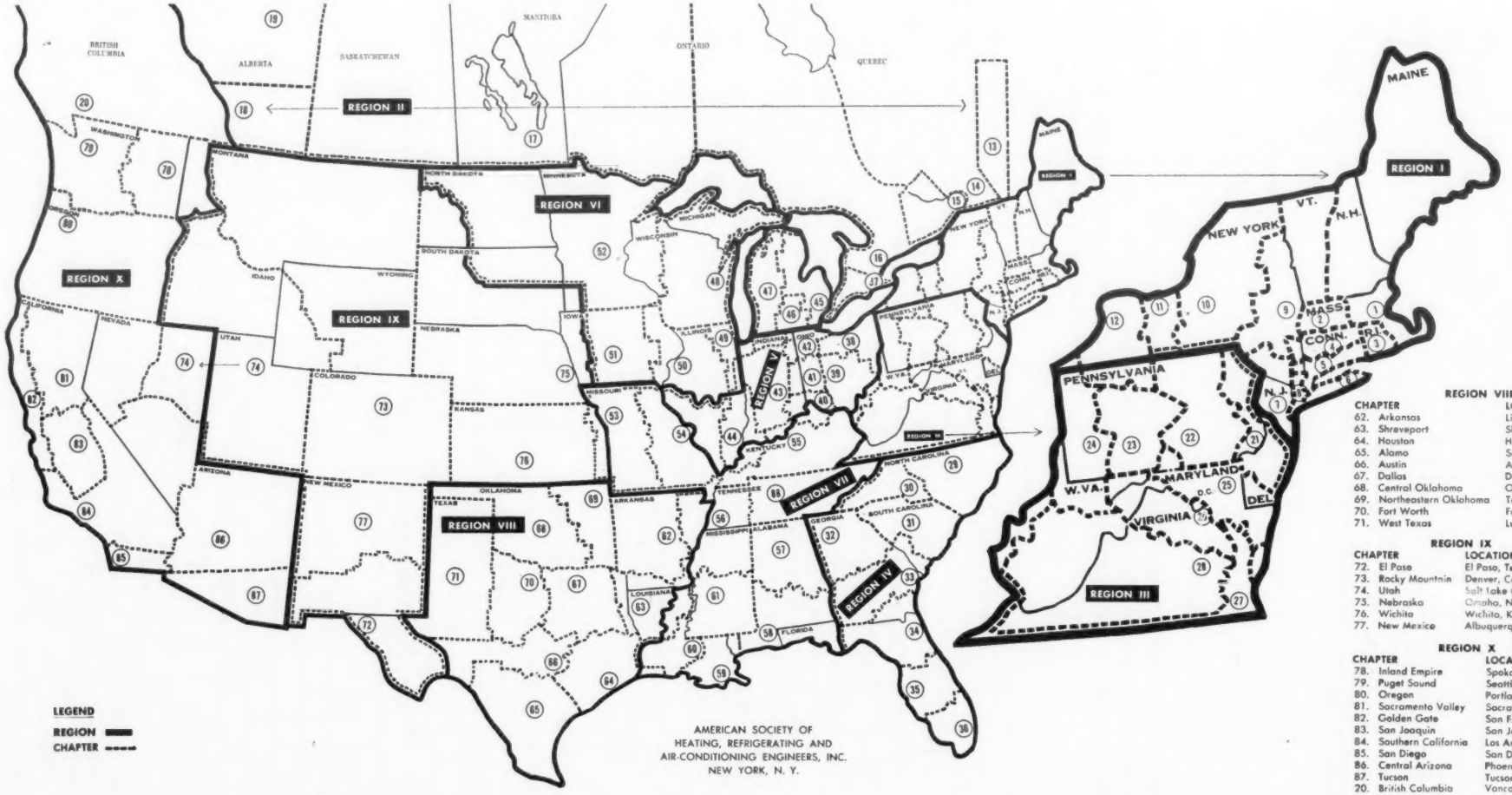
CHAPTER	LOCATION
38. Cleveland	Cleveland, Ohio
39. Columbus	Columbus, Ohio
40. Cincinnati	Cincinnati, Ohio
41. Dayton	Dayton, Ohio
42. Toledo	Toledo, Ohio
43. Central Indiana	Indianapolis, Ind.
44. Evansville	Evansville, Ind.

REGION VI

CHAPTER	LOCATION
45. Michigan	Detroit, Mich.
46. Central Michigan	Battle Creek, Mich.
47. Western Michigan	Grand Rapids, Mich.
48. Wisconsin	Milwaukee, Wis.
49. Illinois	Chicago, Ill.
50. Illinois-Iowa	Moline, Ill.
51. Iowa	Des Moines, Iowa
52. Minnesota	Minneapolis, Minn.

REGION VII

CHAPTER	LOCATION
53. Kansas City	Kansas City, Mo.
54. St. Louis	St. Louis, Mo.
55. Louisville	Louisville, Ky.
56. Memphis	Memphis, Tenn.
57. North Alabama	Birmingham, Ala.
58. Mobile	Mobile, Ala.
59. New Orleans	New Orleans, La.
60. Baton Rouge	Baton Rouge, La.
61. Mississippi	Jackson, Miss.
88. Middle Tennessee	Nashville, Tenn.



REGION VIII

CHAPTER	LOCATION
62. Arkansas	Little Rock, Ark.
63. Shreveport	Shreveport, La.
64. Houston	Houston, Tex.
65. Alamo	San Antonio, Tex.
66. Austin	Austin, Tex.
67. Dallas	Dallas, Tex.
68. Central Oklahoma	Oklahoma City, Okla
69. Northeastern Oklahoma	Tulsa, Okla.
70. Fort Worth	Fort Worth, Tex.
71. West Texas	Lubbock, Tex.

REGION IX

CHAPTER	LOCATION
72. El Paso	El Paso, Tex.
73. Rocky Mountain	Denver, Colo.
74. Utah	Salt Lake City, Utah
75. Nebraska	Omaha, Neb.
76. Wichita	Wichita, Kans.
77. New Mexico	Albuquerque, N Mex

REGION X

CHAPTER	LOCATION
78. Inland Empire	Spokane, Wash.
79. Puget Sound	Seattle, Wash.
80. Oregon	Portland, Oreg.
81. Sacramento Valley	Sacramento, Calif.
82. Golden Gate	San Francisco, Calif.
83. San Joaquin	San Joaquin, Calif.
84. Southern California	Los Angeles, Calif
85. San Diego	San Diego, Calif.
86. Central Arizona	Phoenix, Ariz.
87. Tucson	Tucson, Ariz.
20. British Columbia	Vancouver, B C Can

New Heat Pump and Water Cooler Standards Available

A. T. BOGGS, III
ASHRAE Technical Secretary

A proposed revision to Standard 18-56 Methods of Testing for Rating **Self-Contained Mechanically-Refrigerated Drinking Water Coolers** and Proposed Standard 39P Methods of Testing for Rating **Unitary Heat Pumps for Air Conditioning** have been approved by the Standards Committee and review copies are available from the technical secretary. Comments on these standards will be received until April 15.

Acoustics: The new American Standard S1.1-1960 on acoustical terminology is available from ASA at $4.50.

Certification: Managing Director J. F. Miller of Nema has announced that manufacturers of room air conditioners through their Nema Section will launch a voluntary certification program under which the cooling or heating performance of their products will be certified. This program will be initiated starting with the 1962 models. The testing will be under the supervision of Electrical Testing Laboratories in New York City. It is planned that a certification directory will be published periodically by the Nema Room Air Conditioner Section. This directory will contain the names of new participants as well as those of companies which have been dropped from the list along with reasons for such action. Certification seals may be applied to all units which have been approved and for which data has been supplied to ETL.

Controls: Nema standards covering automatic temperature controls for oil burner primary controls and automatic gas valves have been published and are available from Nema. Publication DC 8-1960 covers Automatic Gas Valves and copies are available from Nema at 30c each. Publication DC 9-1960 covers Oil Burner Primary Controls; copies are available at 30c each.

Instruments: Recommendations for the location of instrument and control connections for power boilers are available from the Recorder-Controller Section, Scientific Apparatus Makers Association, 370 Lexington Ave., New York 17, at $3 each. These recommendations are included in the SAMA publication "Recommended Standard Instrument Connections" and represent a joint effort between SAMA and members of the American Boiler Manufacturers Association. The present recommendations cover units in the 50,000 to 300,000 lb. of steam per hour range.

Insulation: A standard for mineral wool building insulation has been published by the National Mineral Wool Insulation Association. The standard defines thermal performance categories for ceiling, wall, and floor in terms of both "U" values and installed residence units or product designation. The Association's standard also details the physical requirements of mineral wool insulation. Tolerances are specified for vapor permeance of facings, dimensions, resistance to mold and decay, thermal performance, and fire resistance. Test methods are also included. An abbreviated form of the standard confined to thermal performance has been published. Both are available from NMWIA, 1270 Sixth Ave., New York 20.

A new specification for flexible unicellular thermal insulation material in both sheet and tube form has been approved and issued by the manufacturers of the material. Copies are available without charge from the Flexible Unicellular Insulation Manufacturers Task Force, Room 735, 342 Madison Ave., New York 17. The new specification covers the material in both sheet and tube form, the latter for piping covering on cold lines.

Symbols: A new American Standard, ASA Y 32.12-1960 on metallizing symbols is available from ASA at $1 each. This is the most recent standard covering graphical symbols that has been approved by ASA Sectional Committee Y32. This standard was developed by a task group of the American Welding Society from symbols used in the U.S. and Canada. Contents of this standard are identical with the AWS Standard C2.6-57T.

Refrigerators: American Standard Z21.19-1960 Approval Requirements for Refrigerators using Gas Fuel became effective January 1, 1961. Copies are available from ASA or the American Gas Association.

Piping: The 1960 edition of ASTM Specifications for Steel Piping Materials are available from ASTM, 1916 Race St., Philadelphia 3, at $7 each. The specifications cover: (1) pipe used to convey liquids, vapors and gases at normal and elevated temperatures, (2) still tubes for refinery service, (3) heat exchanger and condenser tubes, and (4) boiler, superheater and economizer tubes. To make the volume complete there also are included specifications for castings, forgings, bolting and welding fittings used in such installations.

Weatherstrip: The Department of Commerce indicates availability of a Commercial Standard for Vinyl Plastic Weatherstrip. Copies of this standard are available from the

(*Continued on page* 137)

They Wanted to Know

Inquiries of the month to ASHRAE Headquarters covered many points as to technical facts, standards, practices, personnel and published references. From these, the following have been selected and condensed as being those replies of some general interest and value to ASHRAE members.

SOLDER IN AN AIR STREAM

To *ASHRAE:*

Would the requirements of Section 9.4 of ASA B9.1-1958, Safety Code for Mechanical Refrigeration, prohibit the use of solder, which melts at less than 1000 F, for connecting expansion valves that are located in air passages of fan and coil sections?

D. M. B.

Paragraph 9.4 means literally that solder which melts at less than 1000 F shall not be used in the air stream of an air conditioning system. In the case of an expansion valve, if it is desired to use a flare joint or a lower melting point solder, they must be located outside the air stream.

GUIDE AND DATA BOOK

To *ASHRAE:*

Through the ASRE DATA BOOK, 1959, Refrigeration Applications, we were informed that the second volume, Air Conditioning Applications, of a four-volume series would be published in 1960. As no further information has been received, will you let us know when this volume will be published?

H. F.
Osaka, Japan

Prior to the merger of ASRE and ASHAE, a four-volume DATA BOOK had been initiated by ASRE. The first volume was concerned with refrigeration applications. The second, which had been planned for 1960, would have covered air conditioning applications. With the merger of ASRE and ASHAE in 1959, the publication plans of both societies had to be reviewed and correlated. It was decided that the information that had been compiled by both ASRE and ASHAE would need to be combined and published in one handbook. This will be called ASHRAE GUIDE AND DATA BOOK. This new publication will be available in two volumes, one on theory and design of equipment and the other on applications. The first of these volumes is nearing completion and will be published early in 1961.

EFFECT OF REFRIGERATED CASES ON TOTAL AIR CONDITIONING LOAD

To *ASHRAE:*

We are interested in securing more information on the effect of refrigerated cases on the total air conditioning load required for a supermarket installation. These cases have remote condenser air or water-cooled. Heat rejected is either carried away by condensing water running into a drain or discharged outdoors by an air-cooled condenser. Does the presence of these refrigerated fixtures materially affect the air conditioning requirements?

R. L.

A check upon members of our Society who are active in this field to see what studies have been developed on this subject or what comments may be available will be made. Since such cases are designed to maintain product temperatures, their full capacity is likely to be required to do this specific function. There may well be some cooling effect for customers when they are in the immediate area of these cases, but we lack engineering data to indicate this quantitive effect.

VENTILATION OF GARAGES

To *ASHRAE:*

Please indicate reference articles on ventilation, particularly those concerning garages built by the firm of consulting engineers of Ralf Burke.

C. S. T. B.
Paris, France

We do not have any reference here concerning this consulting engineering firm, nor is it listed in the standard indexes of consultants for the U. S. The company to which you refer may have a brochure on specific installations designed and installed by their firm. As far as the ventilation of garages is concerned, it is suggested that you obtain a copy of Bulletin #88 from the National Fire Protection Association.

ADVANCED TRAINING

To *ASHRAE:*

I intend to specialize in refrigeration and air conditioning engineering. In that connection, I seek your advice about advanced studies and practical training in the U. S. I desire the following information:

1. Names and addresses of colleges which impart specialized instruction in this field.
2. Details of air conditioning and refrigeration engineering firms which might provide part-time jobs during the college year and full-time jobs during vacations.

S. U. R.
Karachi, West Pakistan

There are two colleges in the U. S. presently offering four-year courses leading to a Bachelor of Science degree in air conditioning, heating or refrigeration. These are North Carolina College of Agriculture and Engineering, Raleigh, N. C., and California State Polytechnic College, San Luis Obispo, Calif. In addition, most of the engineering colleges have elective courses in the fundamentals of air conditioning, heating or refrigeration that are available to students of engineering. It is suggested that you contact the Institute of International Education for assistance in continuing your education in the U. S. It is possible that they may also be able to indicate manufacturers that would be able to provide part-time employment during your college sessions.

SAFETY CODE FOR MECHANICAL REFRIGERATION

To *ASHRAE:*

We operate an ice plant and cold storage in Tampa, Fla. The city code as to operation of this kind is based on the ASA B9-1939 ASRE code which requires a certain number of engineers of one or more classes when the plant is in operation.

We plan to discontinue our ice operation, at which time fully automatic equipment will be installed in the engine room. Throughout the country we have a number of fully-automatic cold storages, of which several have engine rooms, where compressors and all other equipment is fully protected against damage or failure, that run unattended.

In these engine rooms in a number of cases, engineers are not used around the clock, but one first-class engineer is employed to supervise maintenance of the plant and equipment. In the ASRE DATA BOOK, under Codes, I note a code (formerly ASRE 15) listed as ASA B9-1953. If this code does not cover an operation as described above, do you plan to revise it to cover a fully-automatic cold storage operation of this kind?

R. A. S.

No edition of the Safety Code includes information or regulations relative to the operation of systems. Whether or not such a system requires a specified number of engineers or operators is a local problem and not one for the standard itself. For your information, I have sent a copy of the 1958 edition of the Safety Code. A number of changes were made in the 1958 edition which may affect your operation.

BUS AND TRAIN AIR CONDITIONING

To *ASHRAE:*

We have an inquiry from one of the largest transportation companies in Japan asking for technical data involving the design and use of air conditioning systems in both buses and electric trains. Do you know of a consulting engineering firm that may assist us with our problem?

P. M.

To get a comprehensive picture of the extent of air conditioning for passenger comfort in trains and buses, it is suggested that you contact the major bus manufacturers and either major rail lines or the American Association of Railroads. These sources also may suggest consultants.

Evaluation of *Wet-Bulb Data* for cooling equipment design



LOREN W. CROW
Member ASHRAE

The capacity and efficiency of any cooling tower which uses the unmodified atmosphere as an agent for carrying off heat must depend on the characteristics of the atmosphere at the specific point on the globe where the cooling tower is located.

It will be assumed here that the reader is familiar with how wet-bulb temperatures are measured. It will also be assumed that the reader understands that any scale of wet-bulb values is approximately the same as the enthalpy scale on a psychrometric diagram.

Design engineers who make decisions related to buying, building, or selling evaporative cooling towers, that operationally must deliver cooled fluid of not more than some specified maximum temperature, must concern themselves with the variable nature of the atmosphere. A decision in economics is required for each particular installation. If the cooling tower is larger than required, its cost will be unnecessarily high. If the cooling tower is too small, it will not accomplish its assigned task and heavy monetary losses may result.

Cooling towers are built to last for several years, and their ultimate capacity is tested during the summer months when wet-bulb temperatures reach their highest readings at any specific locality. However, the temperature sequence is not the same in any two summers. Fig. 1 shows in a general way the relationship between fluctuating wet-bulb temperatures and design specifications.

In the historical development of cooling tower installation, it is unfortunately true that personal points of view rather than basic detailed wet-bulb frequency data have often influenced the selection of design criteria. With a client who is willing to pay the bill, it is only natural that a conservative consulting engineer will tend to over-design.

If there are instances of radical over-design, it is only natural that a careful engineer employed by a cooling tower manufacturer will find ways to save his employer money and still produce and install a completely adequate tower.

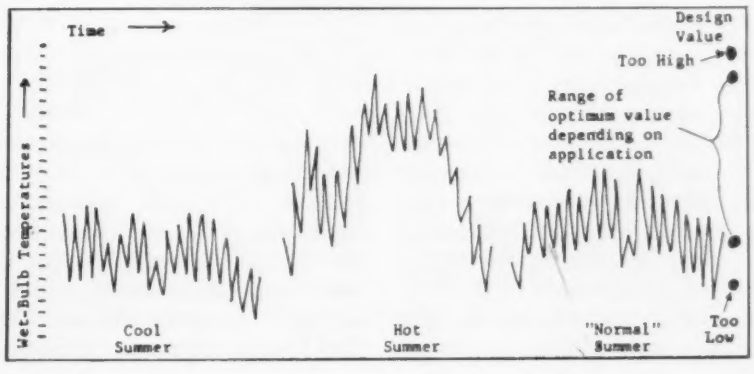
Should the manufacturer adjust downward by a similar factor, the specifications of another more careful and precise consulting engineer, there is great danger of producing a tower which will fail. However, any such failure may not become apparent for two or three years after the tower is placed in service. The first summer, or even two summers following installation, may be abnormally cool. (See Fig. 1.)

In order to furnish engineers with adequate basic data for selecting proper design wet-bulb values, one manufacturer of cooling towers has supported an extensive tabulation* of detailed wet-bulb values. Over ten million hourly weather observations have been counted by electronic tabulation methods to develop the actual frequency, by degrees, of wet-bulb temperatures at 396 locations within the United States and 36 foreign

Loren W. Crow is a Consulting Meteorologist. This paper was prepared for presentation at the ASHRAE Semiannual Meeting, Chicago, Ill., February 13-16, 1961.

* A summarization of the tabulations can be found in the book, *Evaluated Weather Data for Cooling Equipment Design.* Fluor Products Company.

Fig. 1 Illustration of variable wet-bulb temperature sequences as related to selection of design criteria for cooling towers (summer time scale schematic only)



locations. The time period of observations was during the ten-year span, 1948 through 1957. The material in the published book comprises the most comprehensive treatment of summer wet-bulb temperature frequencies available, and it is based on actual observations made by trained observers.

It is hoped that the expanding use of the published material will lead to more careful selection of design criteria and fewer and fewer mistakes which heretofore may have been due to lack of detailed weather data.

Those concerned with design problems may be interested in a brief review of some of the topical material covered in the book.

TEMPERATURE VARIATIONS

Weather sequences are such that any one element such as the wet-bulb temperature shows a broad range of variability with time. This variability is noticeable whether days, months, or seasons are being considered.

DAILY TEMPERATURE SEQUENCES

In Fig. 2 a series of graphs of dew-point, wet-bulb, and dry-bulb temperatures for the lower 1000 ft of the atmosphere are given to show a typical daily pattern of temperatures and lapse rates.

The small arrows at 9:00 a.m., noon, and 3:00 p.m. in Fig. 2 indicate the convection which is brought about by the heating of the air near the earth's surface. Initially, conduction increases the dry-bulb, wet-bulb, and dew-point temperatures near the earth's surface, but by the early afternoon hours the increased convective currents have brought dryer air down from higher elevations, and the dew-point is markedly decreased.

Since the wet-bulb temperature is dependent on both the dry-bulb temperature and the moisture content of the air, the wet-bulb temperature is lower at 3:00 p.m. than it is at noon. Then it increases again when the convective currents cease in the late afternoon hours. Note that during the nighttime hours an inversion of the dry-bulb temperature occurs in the lower few hundred feet.

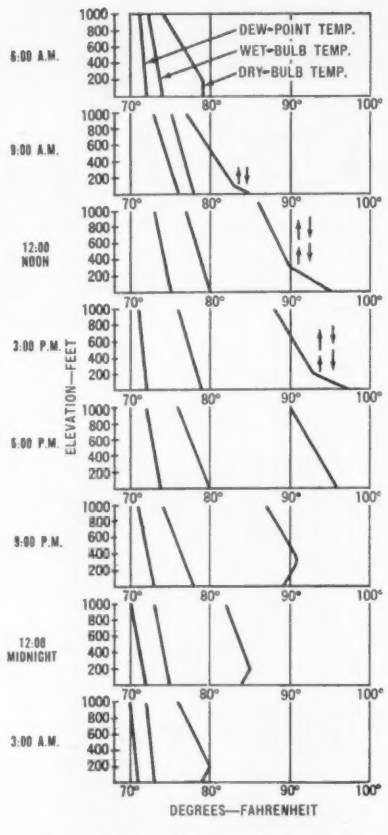


Fig. 2 Typical variation of dew-point, wet-bulb, and dry-bulb temperatures in the lower 1000 ft of the atmosphere

At any particular location the maximum wet-bulb temperature is reached at a time when there is high moisture content. The dry-bulb temperature generally would not be at its record maximum for that location at the same time. Conversely, the conditions which exist when the dry-bulb temperature maximum is reached will ordinarily occur at periods when there is less total moisture content and thus lower wet-bulb temperatures.

To illustrate this point, Fig. 3 shows a comparison between the actual daily wet-bulb and dry-bulb sequences at Dallas, Texas, on the peak wet-bulb and dry-bulb days in 1957. Somewhat by coincidence, these two days occurred only two days apart in the 1957 season.

The air mass which prevailed through the evening hours of July 30 was a dry, hot mass with air moving from the southwest or west over Dallas. At midnight the dry-bulb temperature was 90 F and the wet-bulb temperature was 74 F. The hourly sequence of wet-bulb

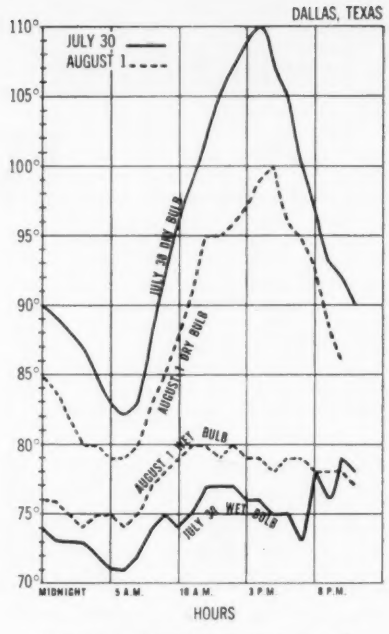


Fig. 3 Hourly sequence of dry-bulb and wet-bulb temperatures on hottest dry-bulb day and hottest wet-bulb day at Dallas, Texas, during 1957 summer season

and dry-bulb temperatures shows a decrease in both these elements between midnight and 6:00 a.m. A rapid increase in both wet-bulb and dry-bulb temperatures took place from 6:00 a.m. until noon, except for a hesitation in the wet-bulb climb at 9:00 a.m., probably caused by convective currents carrying moisture aloft and bringing in dry air from above. By noon the maximum wet-bulb temperature was reached. This held steady for 2 hours as the dry-bulb temperature continued its movement upward. The peak dry-bulb temperature of 110 F was reached at 4:00 p.m., at which time the wet-bulb temperature had decreased by 1 F from its maximum, which prevailed from noon to 2:00 p.m.

On that specific day, between 7:00 and 8:00 p.m., the wind shifted and a different air mass which had originated in the Gulf of Mexico moved over Dallas. This brought a sharp rise in the moisture content. July 31 was a relatively hot, moist day, and the peak for wet-bulb temperatures was reached on August 1. The hourly sequence shows a pattern similar to that for July 30, but the wet-bulb temperatures are higher while the dry-bulbs are lower. The maximum wet-bulb temperature was reached

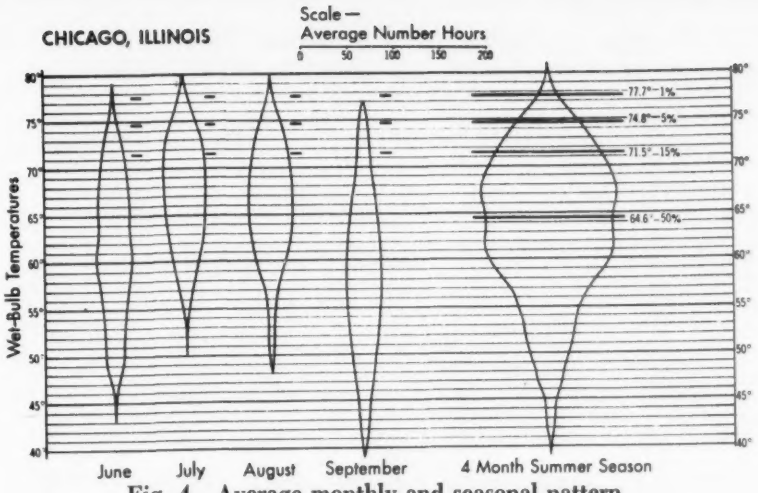


Fig. 4 Average monthly and seasonal pattern of wet-bulb temperatures during the summer months of June through September at Chicago, Ill.

on August 1 at 11:00 a.m. and continued high through 7:00 p.m.

The maximum dry-bulb temperature of 100 F occurred at 5:00 p.m., six hours after the maximum wet-bulb temperature had been recorded. The temperature fell rapidly from this peak, being only 95 F at 7:00 p.m. Both temperatures dropped from 7:00 p.m. to midnight. A comparison of the two extreme days shows that:

The maximum wet-bulb temperature at Dallas was reached when the dry-bulb temperature was between 90 and 95 F.

The actual maximum dry-bulb temperature on the hottest dry-bulb day was some 15 F higher than 95 F (110 F).

The peak dry-bulb temperature on the hottest dry-bulb day was reached when the wet-bulb temperature was 3 F less than it was on the peak wet-bulb day.

MONTHLY VARIATIONS OF WET-BULB TEMPERATURES

The number of hours that the wet-bulb temperature is above any particular value varies at any locality for the same month from year to year. The month of July in one year might have 6 or 8 hot spell days, whereas the next year might have none or only one or two.

Should an attempt be made to use only one year as typical of the array of the climatic range of wet-bulb temperatures, there would be a great risk that this specific year would not be representative of the longer period average. In this study, a 10-year sequence of data has been tabulated which results in good average indications for each station.

In Table I is shown the 10-year July record of high- wet-bulb temperature frequencies at Omaha, Neb.

The number of hours when the wet-bulb temperature was 73 F or more at Omaha during the 10-year period has ranged from 28 in 1950 to 386 in 1957. The 10-year average is 233.

Although values presented for stations in the published book are shown as average conditions covering a 10-year span, it is important to understand that the average was derived from a series of data which reflect noticeable fluctuations for the same month or for the season as a whole from one year to the next. It is possible that on rare occasions a design should be based on the recorded highs rather than the averages. The necessary detailed information is available, although it does not appear in the book.

SEASONAL VARIATIONS OF WET-BULB TEMPERATURES

Although the summer period treated in the book covers the four months of June, July, August, and September, most of the notably high wet-bulb temperatures occur during the two months of July and August at most stations.

To illustrate the seasonal fluctuation in wet-bulb temperature frequency, the monthly pattern, which in turn produces the four-month seasonal total, is presented for five locations in the United States.

The arrays at Chicago, Ill., Fig. 4, illustrate the fact that nearly all the top wet-bulb temperatures in the four-month seasonal period actually were contributed during the months of July and August; virtually none of the hours in the upper 1%, and but a few of those in the upper 5%, were recorded in June and September.

The lower end of the array for the four-month seasonal period is comprised of hours contributed by the months of June and September. During these two months it is possible to have air masses over Chicago which are considerably cooler and dryer than those experienced in the peak warm period of July and August.

When low design values are so chosen that the entire population of such wet-bulb temperatures is not recorded in the four summer months, June through September, it would become necessary to estimate the numbers of such hours contributed by the months of May and October.

HOT SPELL WEATHER

If wet-bulb temperatures had the same large fluctuation in a 24-hr period as that which is common for dry-bulb temperatures, it would be possible in some types of installations for the cooling tower equipment to make up during the cooler night-time hours much of the loss occurring during the peak heat period of the day (a flywheel effect).

However, in the case of wet-bulb temperatures, it is somewhat typical that during hot spells the wet-bulb temperatures show but little fluctuation during the 24-hr periods.

By examination of several hot spell sequences at various stations it was determined that if one moves down from the top to the 15th percentile level in the population of all the June through September hours, this will be a value which will be exceeded for one or more full 24-hr periods per summer season. Thus it was concluded

that a low recommended design limit should be at the 15th percentile level of all hours, June through September.

WET-BULB DESIGN VALUES

The primary purpose in the preparation of the book was to present the best available information in a manner that would be the most helpful to the engineer in choosing optimum design values.

As previously noted, the data upon which the reported information is based were obtained from the most reliable sources available. Hourly observations in the majority of cases were made continuously for a 10-year period. The portion representing the 4-month period, June, July, August, and September, has been analyzed and the results presented in such a way that the designer can choose the specific wet-bulb temperature for a given locality that will be above the wet-bulb temperatures of any given percentage of the total hours of the period. This wet-bulb temperature is more usefully designated as the value equalled or exceeded a given number of hours or a given percent of the total hours.

There are 2928 hr in the 4-month summer period. A 1-% design criterion would entail approximately 30 hr. Therefore, a statement that a specific wet-bulb temperature had to do with the 1-% level would mean that for any year during the months of June, July, August, and September the normal expectancy would be for 30 hr to be at or above the noted wet-bulb temperature. Similarly, the 5 and 15-% levels would have to do with the wet-bulbs that would be equalled or exceeded for approximately 150 and 450 hr, respectively.

The frequency array shown in Table II is a cumulative total of the number of hours at which the noted wet-bulb temperatures were equalled or exceeded, starting from the highest temperature and working downward through the entire sample of wet-bulb temperatures for each station.

Table II is an excerpt from a rather entensive table which is included in the book, showing the detailed tabulations at 432 locations.

TABLE I
TEN SEASONS OF JULY HIGH WET-BULB TEMPERATURES AT OMAHA, NEBRASKA

Wet Bulb, F	Hours 1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
82					3					1
81					2		1		1	7
80	1	6		11	5	12	3		2	9
79	5	9		8	7	16	9	1	3	12
78	15	39		18	29	8	10	6	9	21
77	14	34		17	34	19	20	27	14	45
76	18	53	2	26	25	31	28	55	6	68
75	32	60	4	42	34	45	34	80	13	75
74	53	46	7	33	25	34	53	105	17	81
73	38	27	15	36	65	37	43	101	97	67
Totals	176	274	28	191	229	202	201	375	162	386

TABLE II
HOURLY FREQUENCY OF WET-BULB TEMPERATURES

City	Wet-Bulb Temperatures 82	81	80	79	78	77	76	75	74	73	72	71	70	69	68
	Number of Hours During Average Summer Season (June Through September) That Wet-Bulb Temperatures Equal or Exceed the Specific Degree Fahrenheit Value Shown Above														
Chicago	1	2	4	10	21	46	79	131	207	286	387	504	632	751	889
Tulsa	2	4	11	29	74	165	306	532	753	993	1241	1452	1674	1835	1981
Philadelphia	1	2	6	15	40	87	148	240	351	483	641	787	950	1107	1256
Lubbock, Tex.							1	4	12	32	91	200	386	611	876

City	Alt. Above Sea, Ft	Wet-Bulb Temperatures at the Four Specific Frequency Levels Listed Below: 1 Percent	5 Percent	15 Percent	50 Percent
Tulsa	674	77.7	74.8	71.5	64.6
Chicago	623	79.0	77.2	75.4	70.9
Philadelphia	114	78.4	76.0	73.3	66.6
Lubbock, Tex.	3242	73.1	71.5	69.8	65.9

In addition to the table, isoline maps of the three design levels, 1, 5, and 15% are presented.

One of the truly new tabulations presented deals with the dry-bulb temperatures which occur coincident with high wet-bulb readings.

At 49 locations scattered throughout the entire country, complete coincident arrays were made by each degree of dry-bulb temperature and each degree of wet-bulb temperature for the higher summer wet-bulb temperatures. These stations have been given special treatment to show the pattern of coincident wet-bulb and dry-bulb temperatures which prevail in the areas represented. The frequency patterns are portrayed on psychrometric charts.

Another feature shown for the first time is the presentation of winds which occur coincident with high wet-bulb readings. Velocity gradations and concentrations of direction are indicated for all stations throughout the United States.

Final section of the book presents a comprehensive treatment of the problems faced in interpolation from the known points of weather station measurements to specific locations where cooling installations are to be made.

WHO'S WHO IN ASHRAE

Insofar as possible these listings will each appear twice a year

ASHRAE OFFICERS, DIRECTORS COMMITTEES, STAFF
See page 98, this issue

REGION AND CHAPTER OFFICERS
See page 82, November JOURNAL

RESEARCH AND TECHNICAL COMMITTEES
See page 67, September JOURNAL

STANDARDS PROJECTS
See page 88, January JOURNAL

INTER SOCIETY COMMITTEES
See page 84, November JOURNAL

Past-President

Everett Owen Eastwood

1876 - 1960



Past-President of the former American Society of Heating and Ventilating Engineers and Professor Emeritus of the University of Washington, Everett Owen Eastwood died on December 15, 1960.

Born February 5, 1876, in Portsmouth, Va., he was the son of Matthew D. and Mary Anne (Thornton) Eastwood. He was educated at the University of Virginia, achieving the degrees of C.E. in 1896, B.S. in 1897 and A.M. in 1899. In 1902 he received a B.S. in Naval Architecture from Massachusetts Institute of Technology, and from 1897 to 1900 he was a Fellow in Astronomy at the University of Virginia. He married Nelle Dorothy Halliall on December 20, 1905. During the first world war, he was in charge of special training courses for Marine Engineers, U.S. Shipping Board and Naval Ensigns, Naval Recruiting Service at the University of Washington.

Professor Eastwood's teaching career began in 1904, when he joined the staff of Lehigh University as an instructor of mechanical engineering and naval architecture. In the following year he was appointed Assistant Professor of Mechanical Engineering at the University of Washington, followed by his advancement to Associate Professor, Professor and Head of the Department. In 1947 he was named Professor Emeritus.

In 1921, Professor Eastwood became a member of the former American Society of Heating and Ventilating Engineers. Instrumental in organization of Pacific Northwest Chapter, he served as its first president and represented that Chapter on the Nominating Committee from 1928 to 1931. A member of Council in 1931-33, 1937 and 1943, he was elected Second Vice President in 1940, followed by advancement to First Vice President in 1941 and President in 1942. During 1941 he also served as a member of the Executive Committee, Chairman of the F. Paul Anderson Award Committee and Chairman of the Advisory Committee for the Pacific Heating and Air Conditioning Exposition.

Author of many technical magazine articles, he was, in 1930, Associate Editor of Engineering and Finance, as well as Consulting and Contributing Editor of Heating, Piping and Air Conditioning.

Fellow of the American Society of Mechanical Engineers, he was its Manager from 1923-26 and Vice President from 1926-28. From 1929-31 he represented that Society on the American Engineering Council.

Meetings ahead

February 10-11—Air Conditioning and Refrigeration Wholesalers, Annual Convention, Chicago, Ill.

February 13-16 — American Society of Heating, Refrigerating and Air Conditioning Engineers, Semiannual Meeting, Chicago, Ill.

February 13-16 — 15th International Heating and Air-Conditioning Exposition, Chicago, Ill.

March 5-8 — National Association of Frozen Food Packers, Annual Convention and Exposition, Dallas, Texas.

March 27-30—National Association of Refrigerated Warehouses, Annual Meeting, San Francisco, Calif.

March 27-31 — Third National Symposium on Temperature. Sponsored by the American Institute of Physics, Instrument Society of America and National Bureau of Standards, Columbus, Ohio.

April 5-7—Gas Appliance Manufacturers Association, Annual Meeting, Boca Raton, Fla.

April 11-14 — 2nd International Refrigeration and Air Conditioning Exhibition and Technical Convention, sponsored by World Refrigeration, London, England.

April 20-22 — Refrigeration Research Foundation, Annual Meeting, Palm Beach, Fla.

April 23-27 — National Association of Refrigerated Warehouses, Annual Meeting, Palm Beach, Fla.

April 23-27 — Oil Heat Institute, 39th Annual Convention, Washington, D. C.

May 22-25—Design Engineering Show, Detroit, Mich.

June 12-15—National District Heating Association, 52nd Annual Meeting, Portsmouth, N. H.

June 12-15 — Institute of Boiler and Radiator Manufacturers, Annual Meeting, Absecon, N. J.

June 26-28 — American Society of Heating, Refrigerating and Air Conditioning Engineers, 68th Annual Meeting, Denver, Colo.

News of ASHRAE members

Honors and recognitions



E. R. Queer, Fellow ASHRAE, past-President of the former ASHAE and Director and Professor of Engineering Research, Pennsylvania State University, has been appointed to the Air Pollution Commission in the State of Pennsylvania. This Commission, established by a General Assembly Act in January, 1960, consists of five governmental and six public members. Professor Queer is currently a member of the ASHRAE Executive and Long Range Planning Committees.

Keith T. Davis, Manager of Gas Air Conditioning, Bryant Manufacturing Company, has been elected to the Board of Trustees of the National Warm Air Heating and Air Conditioning Association. Re-elected Second Vice President is **Harold P. Mueller, Jr.,** President of the Mueller Climatrol Division of Worthington Corporation.

Ralph C. Downing and **B. J. Eiseman, Jr.,** have been named to the newly-created position of Technical Associate by E. I. duPont de Nemours & Company. This title is awarded to scientists who have achieved recognition as experts in their fields of applied research and who have contributed significantly to the work of the Freon Products Division. Dr. Downing, who received his Ph.D. in chemistry from the University of Virginia, joined duPont in 1941 as a research chemist at the Jackson Laboratory in Deepwater Point, N. J., and in 1948 was assigned to the Freon Products technical sales service section. He has written technical articles on fluorine chemistry, refrigeration and aerosol propellents. Dr. Eiseman received his Ph.D. from Massachusetts Institute of Technology, where he worked for a year as a research associate. He joined duPont in 1941 as a chemist, and for the past 11 years his research has been predominantly in the field of fluorocarbon compounds and their application as refrigerants.



DOWNING



EISEMAN



Tony C. Min, Associate Professor of Mechanical Engineering, Auburn University, recently was awarded a National Science Foundation Science Faculty Fellowship. He plans to carry out his Fellowship program at the University of Minnesota, starting next fall. Prior to joining the instructional and research staff at Auburn in 1957, Professor Min was a research engineer at the ASHRAE Research Laboratory in Cleveland. He has been active in the TAC, RAC and TC of the Society.

New jobs

Erich J. Kocher, Chief Engineer of Vilter Manufacturing Company, has been elected a director of the company. Joining the organization in 1937, he served in both manufacturing and engineering capacities before being named Chief Engineer in 1945. He is an alumnus of Marquette University.

Frank J. Versagi has been named Editor of Air Conditioning, Heating & Refrigeration News. Technical Editor since 1957, he will continue to direct technical editorial activities.

Sidney L. Gayle, Vice President of Long Island Chapter, ASHRAE; **Leonard D. Carr,** immediate past-President of New York Chapter; and **Harry A. King** have joined to form the sales office of Gayle, King & Carr, Inc., manufacturers' representatives in the heating and air conditioning field. Manufacturers represented by the new organization are Cambridge Filter Corporation, Universal Diffuser Corporation, Airtherm Manufacturing Company, Mammoth Furnace Company, Silence, Inc., and Thermal Engineering Corporation.

Richard W. Lehman has been promoted to Manager of the Buffalo, N. Y., sales office of Trane Company. A sales engineer in that office since 1951, he is a 1950 graduate of the University of Buffalo.



Raymond J. Fehrenbach has been appointed Vice President for Manufacturing of Thermo Equipment Corporation. He had joined the organization in 1959. Formerly an engineer supervisor at E. I. duPont de Nemours & Company, Inc., Atomic Energy Division, he designed and developed equipment and plants for separation of nuclear reactor product materials while in that post. He has also been in supervisory positions at several of the facilities of the duPont-operated Atomic Energy Commission Savannah River Plant.

A. J. Horn, 1961 President of the Los Angeles Institute of Heating & Air Conditioning Industries, will head the newly created Engineering Services Department which merges and expands the previous Sales Engineering Departments of Payne Company and Day & Night Manufacturing Company. Most recently associated with the Day & Night organization in both sales and engineering capacities, he was formerly with Payne Company for many years.

John P. Soule, in his new post as Product Manager, Terminal Air Conditioning, American Radiator & Standard Sanitary Corporation Industrial Division, will be responsible for product development and marketing. He will have his office in Dearborn, Mich. A graduate of Stevens Institute of Technology, he joined the Plumbing and Heating Division in 1951. In 1956, he was made Manager, Commercial Heating and Cooling Systems, and later Manager of Hydronic Air Conditioning.

John A. Holbrook, a specialist in hospital and institutional engineering problems, has been appointed to the staff of A. T. Kearney and Company. Prior to joining this organization, he served as administrative engineer at Presbyterian-St. Luke's Hospital. A graduate of the University of Iowa, he is a member, in addition to ASHRAE, of the American Hospital Association, National and Illinois Societies of Professional Engineers and National Fire Protection Association.

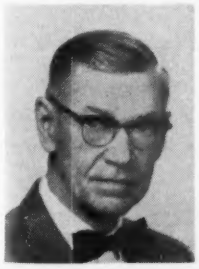


Joseph A. Cutler, President and General Manager of Johnson Service Company since 1938, has been elevated to Chairman of the Board. Following his graduation from the University of Wisconsin in 1909, he stayed on as an instructor. Three years later he joined Johnson as a sales engineer. In the succeeding years he served as branch manager, central district manager and Vice President of Sales. He has also been Chairman of the Executive Committee, which responsibility he will retain in his new post.



Retirements

Richard D. Madison, ASHRAE Fellow, has retired after 41 years of service with Buffalo Forge Company. Joining the company in 1919, he was appointed Director of Research in 1954 and has served subsequently as an engineering consultant. Well known as the Editor of "Fan Engineering," having made the first revision to this handbook in 1925, with later revisions in 1933, 1938, and 1948, he also has contributed a number of papers resulting from his work on fan design; his paper on the subject of elbow loss is still a standard reference. A member of the former ASHAE since 1926, he has served on the Research Committee, Publications Committee and TACs on Air Distribution, Sound and Vibration and Physiological Research. He has been a member of the joint ASHRAE-NAFM Sound Test Code Committee and a



(*Continued on page* 105)

Others are saying

noise . . . caused by most ventilating systems originates, in many cases, within the fan. Here the theory of propagation of broad band noise in a cylindrical duct is compared with measurements and reasonable agreement is found. Suggested, so that the sound power flow may be calculated from the measured sound pressure, is a single measuring position. It is contended that a simple windshield over a microphone will suffice for measurements on most ventilating fans. *Journal of the Institution of Heating and Ventilating Engineers, December 1960, p. 306 (British).*

air pollution . . . measurement techniques have become increasingly important research projects as public interest and concern over air pollution has grown. These techniques range from sampling devices mounted on aircraft to time-lapse photography of low-level inversions to gauging the cellular and subcellular effects of pollutants on experimental animals. To further exchange of information on current research, methods and findings, the Public Health Service sponsored an Air Pollution Research Seminar. Summaries of the 81 papers given at this forum are presented herewith. *Public Health Reports, December 1960, p 1173.*

induced draft fans . . . coupled with stub stacks can eliminate the need for tall stacks on buildings with conventional cast iron and steel heating boilers. Fast, simplified procedures cited as resulting in adequate fan capacities with margin for unforeseen conditions, but avoiding excesses of capacity, are developed here. A discussion of this method explains why induced draft fans are needed, as well as aiding in determination of fan requirements for heating boiler service, when there is an existing stack to be utilized or where the stack recommended by the boiler manufacturer can not be used. *Air Conditioning, Heating and Ventilating, December 1960, p 51.*

Attention! Members who want to receive

ASHRAE BULLETINS PROPOSED

As announced previously in your ASHRAE JOURNAL (October, November and December) the Publications Committee has authorized the issuance of two new BULLETINS, provided these can be made available upon a self-liquidating basis.

The proposed REFRIGERATION BULLETIN would be a 40-page printing of the full text of Chapter 57 as prepared originally for the ASHRAE GUIDE AND DATA BOOK and inclusion of an extensive reference to thermoelectricity as applied to refrigeration practice.

The proposed CAPILLARY TUBES BULLETIN would be a similar printing of the full text of a chapter prepared for the same purpose.

Both of the Chapters had to be reduced greatly in length below original anticipations and thus only condensed versions will appear in the 1961 GUIDE AND DATA BOOK. In their BULLETIN forms each chapter would be complete as to text and illustrations.

However, as issuance is authorized only upon a self-liquidating basis, it is essential for ASHRAE Headquarters to estimate the minimum quantity to be ordered prior to publication. Please indicate your interest in purchasing either or both of these BULLETINS upon the coupons below. If you have ordered already, do not repeat, unless you wish additional copies within the price range indicated.

Unless enough orders are received shortly to total the required minimum, these BULLETINS will not be published.

NAME .....

ADDRESS .....

I am interested in this proposed Refrigeration and Thermoelectric Bulletin and would accept a charge of $1.50 or $3.00.

SIGNATURE .....

NAME .....

ADDRESS .....

I am interested in the proposed Capillary Tube Bulletin and would accept a charge of $1.50 or $3.00.

SIGNATURE .....

Central Residential Air Conditioning Had Big Advance in 1960

Biggest news of 1960 in the air-conditioning and refrigeration field was the "breakthrough" in the installation of central residential equipment by builders of new homes. To be sure, in previous years there had been a considerable volume of equipment installed in homes. But in 1960 the builders of many medium- and low-cost development homes began including central air conditioning as standard equipment. In previous years central systems had been standard equipment in higher-priced homes, and had been optional to the buyers of low- and medium-priced homes. Reports received from all sections of the country—north and south—indicate that buyers are demanding central residential air-conditioning; hence the noticeable trend.

In the field of large central station systems, such as are used in hotels, apartments, office buildings, stores and other multi-room buildings, the industry feels safe in estimating that these installations will have been up at least 10 per cent in 1960 over 1959, when all the returns are in. Total installed value of such systems in 1959 was more than $715 million, and it seems probable that the 1960 figure may well be in the neighborhood of $800 million.

These big systems, which gave most Americans their first taste of air-conditioning in the pre-world War II days, still account for the largest share of the industry's sales, and offer quite a great potential in the industrial field, where only about 10 per cent of all factories are now air-conditioned. We in the industry feel that the case histories of factories and offices whose efficiency indices have gone up sharply with the installation of air-conditioning are beginning to have a cumulative effect on non-air-conditioned establishments, and that 1961 and subsequent years of the 60's will see a snowballing in the percentage figure for air-conditioned work places.



G. S. JONES, JR.
Member ASHRAE

Automotive air-conditioning is becoming a bigger factor each year, as the manufacturers of cars of all sizes produce an increasingly large number of models factory-equipped with air-conditioning and the size of the industry which manufactures units for so-called field installation continues to increase. While the automotive air-conditioner has not reached the widespread use that the automobile heater has achieved, its popularity is increasing, and the day may not be too far distant when 50 per cent of all automobiles may be equipped for comfort in summer as well as in winter. The Society of Automotive Engineers has estimated that by 1962 one in nine cars will be air-conditioned, and 25 per cent of all cars produced within five years will be factory-equipped with air-conditioning.

In the field of commercial and industrial refrigeration, the longer-established phase of mechanical cooling, 1960 has been, as indicated above, quite a good year for most of the many products covered in this broad category, and forecasts of increased marketing facilities for foods, more than three-fourths of which are cooled at some point along the route from producer to consumer as well as building outlook and developments in scientific and defense applications, all point to a further step-up in utilization of the equipment which is necessary to the daily movement of the nation's food supply, medical and scientific welfare, and defense operations.

Military uses for specialized cooling equipment have shown great growth in the past few years, as highly-intricate electronic processes, weapons systems, test facilities, supersonic aircraft, and nuclear-power applications have become an ever-greater part of the nation's defense equipment. As these developments, and those which grow out of them, progress even further, the essentiality of mechanical refrigeration to their production and operation will become more apparent and vital.

Today, after a year in which business activity generally has been reported as "spongy," our industry can look back on 1960 as one in which it has not only held its own, but has shown concrete gains in most areas — and still looks ahead to the greatest decade in history.

G. S. Jones, Jr., is Managing Director of the Air-Conditioning and Refrigeration Institute.

ASHRAE

NATIONAL MEETINGS AHEAD

1961	1962	1963
Feb. 13-16 Semiannual Chicago, Ill.	Jan. 28-Feb. 1 Semiannual St. Louis, Mo.	Feb. 11-14 Semiannual New York, N. Y.
June 26-28 Annual Denver, Colo.	June 25-27 Annual Miami, Fla.	

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Vortex Tube Cooling for Supersonic Craft

Separation of hot from cold molecules in shock-compressed air, by means of the Hilsch vortex tube, may provide direct air cooling of electronic equipment in coming supersonic aircraft.

As projected by engineers of the Heat Transfer Laboratory of the Hallicrafters Company, the tube will act much as does a cream separator, except that it has no moving parts. Its function is to separate the lower energy (lower temperature) molecules of a stream of compressed air at elevated temperatures.

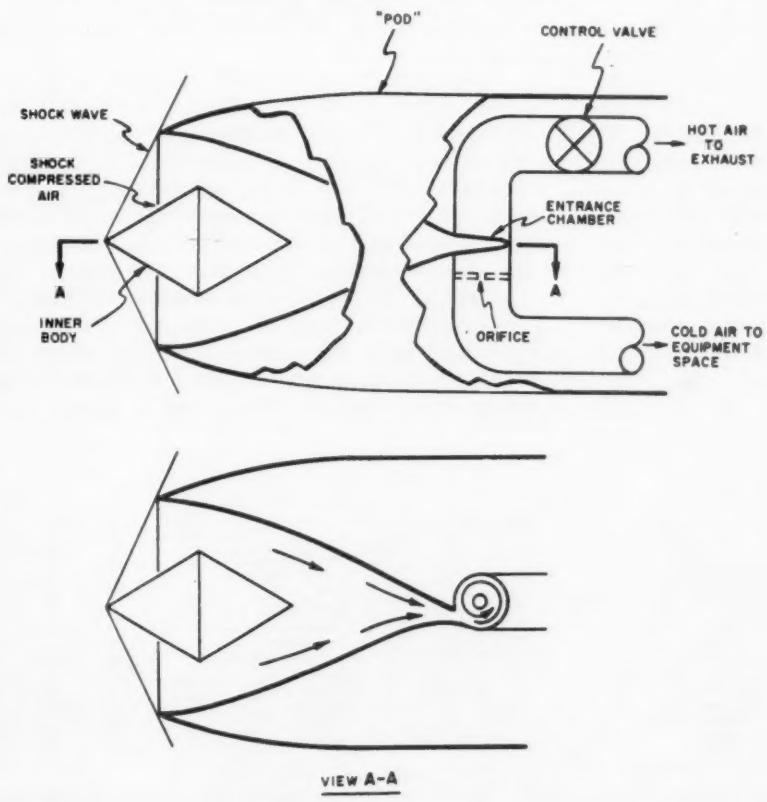
Equipment to be cooled will be housed in a "pod" attached to the aircraft. An inlet resembling that of a ram jet engine will admit shock compressed air to the Hilsch tube.

Air enters the tube tangentially and is spiralled into a vortex. A strategically placed orifice bleeds off the low energy particles for equipment cooling while the hotter high energy air particles are exhausted outboard. A valve in the hot line controls the relative air flows, effectively regulating the air temperature downstream from the orifice.

With an ambient air temperature of 60 F, the stagnated tube inlet air temperature of an aircraft at Mach 2, sea level altitude, is 474 F. Based on the Maxwell-Boltzman distribution of air molecule velocities under these conditions, it may be demonstrated that 65% of the air molecules accepted by the tube have a mean velocity corresponding to an air temperature of 131 F. Ideally, 1.0 lb of air per min at 131 F can be extracted from every 1.54 lb/min of air at 474 F entering the vortex tube.

Allowing for considerably less than ideal performance, engineers feel the simplicity of the Hilsch tube promises sufficient savings in weight, space, power and cost over mechanical refrigeration systems to become a strong contender for consideration in future aircraft designs.

Proposed Hilsch vortex tube application for supersonic equipment



What ASHRAE Chapters are doing

Discussions at recent meetings contrasted electric energy with natural gas and electric with steam absorption refrigeration. Other equipment highlighted includes centrifugal pumps, refrigerant distributors and double-duct high velocity systems.

PHILADELPHIA . . . At the pre-dinner educational session on December 8th, Walter E. Rosengarten of Philadelphia Electric Company presented an illustrated talk on "Gas-Fueled Air Conditioning Equipment."

Francis H. Buzzard of Charles S. Leopold Engineers, Inc., spoke on "Some Unusual Problems in Heating and Air Conditioning Design," illustrating his discussion with slides. Installations described included the New York Stock Exchange and Madison Square Garden.

who's doing what . . . A. C. Caldwell and H. H. Erickson were presented with Life Member certificates at the December meeting.

KANSAS CITY . . . Humidification of residential, office and industrial buildings was discussed by Vice President Lewis of Walton Laboratories, Inc., guest speaker at the December 5th meeting. Following his talk was a question and answer period.

who's doing what . . . James Dukelow, Chairman of the Membership Committee, reported 14 new Chapter members.

DAYTON . . . Presenting the results of a recently conducted survey, Consulting Engineer Daniel C. McCoy spoke at the December meeting on "Tobacco Smoke – What To Do About It?" Indicated in this survey is that a greater percentage of people (smokers as well as non-smokers) is annoyed by tobacco smoke. This annoyance ranges from slight irritation to nausea and is caused by both fresh smoke and "play-back" of stale smoke retained by clothing, air conditioner coils and other materials.

Speaker McCoy pointed out that none of the three principal methods of dealing with the tobacco smoke problem in air conditioning systems is wholly satisfactory: dilution with outside air requires large quantities of air; electrostatic precipitation removes particles but not gases; activated carbon requires periodic servicing. Suggested was a return to restrictions on smokers.

James H. Downs, Region V Director, appeared before the membership to outline advantages to ASHRAE and to the engineering profession of the United Engineering Center Building.

who's doing what . . . N. O. Mitchell is Committee Chairman for the local UEC Building Fund Drive. Committee members are B. Booher, P. H. Hopper and R. L. Kiefer.

ST. LOUIS . . . Members attending the December 19th meeting heard John H. Carter of Frick Company moderate a panel discussion on "Industrial Refrigeration."

Reporting on "Problems of Large Users," Robert L. Best, Superintendent of Utilities at Anheuser Busch, detailed difficulties encountered by his company. Refrigeration units in the organization's six plants range from 150 to 6500 ton in capacity and from belt-driven to balance VW and centrifugal systems. Utilized in one plant are halogenated hydrocarbon refrigerants, the others use ammonia. Brine, such as salt, glycol or alcohol, is used by all. Refrigeration equipment in two plants is turbine-driven; the rest is electrically-driven.

Ammonia will compete with halogenated hydrocarbon refrigerants in every way except in the matter of safety, speaker Best contended, and economic considerations dictate its use. Problems of the large user outlined by him include repair parts, humidity control, oil return, brine corrosion and floodback.

Designed to be used for comfort or process control, "Absorption and Centrifugal Systems" were discussed by Charles O. Beacham, Sales Engineer of Carrier Corporation. Company records, he stated, show that with use of air conditioning there has been a 7 to 14% increase in production, 30 to 40% lower employee turnover and less absenteeism.

"Reciprocating Compressor Systems" were covered by William Norris, District Manager of Vilter Manufacturing Company. A major problem cited by him is valve life, as they are affected by excessive discharge temperature or flooding. Current design limitations on valves used in reciprocating

CHAPTER MEETING DATES

	Feb.	Mar.	Apr.
Alamo	—	—	—
Arkansas	21	21	18
Atlanta	13	13	10
Austin	16	16	20
Baltimore	2	2	6
Baton Rouge	15	21	18
Boston	—	—	—
British Columbia	15	15	12
Central Arizona	6	6	3
Central Indiana	25	14	11
Central Michigan	14	14	11
Central New York	—	8	—
Central Oklahoma	13	13	10
Central Pennsylvania	8	8	12
Cincinnati	—	—	—
Cleveland	13	13	10
Columbus	20	20	17
Dallas	20	20	17
Dayton	14	14	11
El Paso	20	20	17
Evansville	7	7	4
Florida West Coast	—	—	—
Fort Worth	—	—	—
Golden Gate	—	—	—
Hampton Roads	7	7	4
Houston	17	17	21
Illinois	13	13	10
Illinois-Iowa	20	20	17
Inland Empire	13	13	10
Iowa	13	13	10
Jacksonville	—	—	—
Johnstown	14	14	11
Kansas City	6	6	14
La Ville de Quebec	14	14	11
Long Island	—	—	—
Louisville	13	13	10
Manitoba	23	23	27
Memphis	20	20	17
Michigan	20	20	17

compressors limit the velocity of ammonia to 12,000 fpm and of halogenated hydrocarbon refrigerants to 6000 fpm. From single piston, slow speed compressors, progress has been made to multiple piston, high speed machines. Current limiting speed on the piston is 600 fpm.

TUCSON . . . Speaking before this group on December 6th, William S. Schock of Dow Chemical Corporation covered the "History of Thermal Insulation" and showed a film on Styrofoam.
who's doing what . . . R. E. Joachim, Chairman of the local UEC Fund Drive, reported that this Chapter has attained 30% of its goal.

WESTERN MICHIGAN . . . Current trend in design when "Building Automation into Control Centers" is for smaller units still capable of providing extensive information. Speaking at the December 12th meeting, Don Plociennik of Johnson Service Company stated that transmission of information is usually by pneumatic or electrical impulse. Slides of control centers and their application were shown.

CENTRAL PENNSYLVANIA . . . Comparing refrigeration installations here and in Poland, Otto J. Nussbaum of Kramer Trenton Company spoke at the December meeting. Slides were shown of various installations in Poland, mainly antiquated and crude, and then of the latest in packaged units.

SACRAMENTO VALLEY . . . Discussing basic principles of thermodynamics relating to refrigeration, William Nero, speaking at the December 7th meeting, emphasized temperature-entropy relationships during mechanical cooling for air conditioning.
who's doing what . . . Lester O'Meara commented at the December session on affairs of the Engineering Council and noted legislation of interest to engineers.

PUGET SOUND . . . One of the largest refrigeration plants in the country, the Glen Canyon Dam installation, was described by Robert E. Lucas of Lewis Refrigeration Company at the December meeting. Slides illustrated major features of the project.

NORTHEASTERN OKLAHOMA . . . Present as special guests at the December 19th meeting were several architects, school board members and school maintenance personnel. Speaker of the evening was G. B. Wadzeck, Superintendent of Schools, San Angelo, Texas.

Using slides, Superintendent Wadzeck began by showing how the teaching program in his district has progressed in the last 50 years. He pointed out that the program must include modern teaching aids, such as motion pictures, television and group lectures, if students are to get as much from the curriculum as they should.

To accompany this enriched program of study, physical facilities, speaker Wadzeck stated, must be of quality that will instill a desire for greater learning. In San Angelo the completely air conditioned elementary and high schools are cited as having increased pupil and teacher efficiency by an estimated 20 to 25%. These schools were built at a cost less than or equal to that of conventional buildings; savings in maintenance have been noted.

MONTREAL . . . Speaking on "Refrigerant Distributors for Direct Expansion Multi-Circuit Evaporators" at a recent meeting, W. H. Krack of Sporlan Valves discussed development of the cooling coil. Addition of coil fins and introduction of halogenated hydrocarbon refrigerants, he stated, produced a higher evaporative pressure drop. In order to feed tubes uniformly, an attempt was made to put a header on the coil. The refrigerant distributor was developed to fill this need. Most satisfactory, the speaker contended, was the aerofin distributor, a centrifugal unit which could be mounted in any way. This has been replaced by a pressure-drop distributor.
who's doing what . . . Ernest N. Jungbluth, shown with Chapter President Guy Forget, was presented



Receiving a Certificate of Appreciation from Montreal Chapter President Guy Forget (at left) is Ernest N. Jungbluth

	Feb.	Mar.	Apr.
Middle Tennessee	14	14	11
Minnesota	13	13	10
Mississippi	27	27	24
Mobile	27	27	24
Montreal	20	20	17
National Capital	8	8	12
Nebraska	14	14	11
New Mexico	—	—	—
New Orleans	—	—	—
New York	28	28	25
Niagara Frontier	6	6	3
Niagara Peninsula	7	7	4
North Alabama	—	—	—
North Jersey	—	—	—
North Piedmont	10	10	14
Northeastern New York	16	20	18
Northeastern Oklahoma	—	—	—
Northern Alberta	—	—	—
Northern Connecticut	9	16	13
Northern Ohio	—	—	—
Ontario	6	6	11
Oregon	16	16	13
Ottawa Valley	—	—	—
Panama & Canal Zone	—	—	—
Philadelphia	9	9	13
Pittsburgh	20	20	17
Puget Sound	14	14	11
Rhode Island	9	8	12
Richmond	—	—	—
Rochester	1	1	5
Rocky Mountain	—	—	—
Sacramento Valley	—	—	—
St. Louis	16	20	17
San Diego	14	14	11
San Joaquin	—	—	—
Savannah	—	—	—
Shreveport	16	16	20
South Carolina	20	20	17
South Florida	14	14	11
South Piedmont	—	—	—
Southern Alberta	21	21	18
Southern California	20	13	10
Southern Connecticut	9	9	13
Toledo	—	6	3
Tucson	7	7	4
Utah	17	17	21
West Texas	24	24	28
Western Massachusetts	16	16	20
Western Michigan	6	13	10
Wichita	20	20	17
Wisconsin	20	20	17

with a Certificate of Appreciation for continued interest and cooperation in the affairs of the Society and the industry in general. Instrumental in organizing Quebec Section of the former ASRE, he was first Chairman of Montreal Section. Also honored was Edward T. Cockman, a long-time Society member.

CLEVELAND . . . Shown at the December meeting was a movie on "Project Mercury," the purpose of which is placing of a manned space capsule in orbit around the Earth and recovering it intact. Guest speaker was Harold Schmidt, a rocket propellant engineer with the National Aeronautical and Space Administration.

First part of the film detailed design of the capsule from initial wind tunnel tests with various models to launching of an Atlas rocket with an actual capsule. In the second part of the film were shown the seven men participating in this program and some of the preparatory training they are receiving.

NEW ORLEANS . . . "Why Electric Energy for Heating and Cooling?" and "Why Natural Gas for Heating and Cooling?" were the topics of E. I. Blanchard of Louisiana Power and Light Company and I. E. Rowe of United Gas Corporation, respectively, guest speakers at the December 13th meeting.

Speaker Blanchard discussed how the ice plant load, which in past years contributed substantially to his company's revenue, has been replaced by the air conditioning load. A general discussion on heat pumps indicated that, in this area, the air-to-air system was most practical, with supplemental heating recommended. He elaborated on the fact that electric heating is low in initial and maintenance cost, flexible, flameless, dependable and that no heat is lost up the stack.

Also pointed out were various applications which lend themselves to use of heat pumps. On all installations the need for stacks, boilers and maintenance engineers is eliminated, reducing cost of the system. Speaker Blanchard's discussion was concluded with slides of residential and commercial buildings utilizing electric heating and heat pumps.

Beginning his discussion by elaborating on the research program of the American Gas Association and citing research being conducted on new fluid for absorption of refrigeration cycle, development of the air-cooled ammonia cycle and thermoelectric refrigeration, speaker Rowe then showed slides of a free piston compressor unit now under development in 50-ton and larger sizes. Also covered were the Lizenzia unit, a combination absorption and evaporated cooling machine; gas-driven heat pumps; and conventional compressors driven by gas-fired internal combustion engines.

Development of gas-fired equipment, such as gas turbines to generate power on the customer's premises, was outlined. In addition to the heating and air conditioning load, this power could be utilized for high frequency light, he stated, and waste heat could be reclaimed. Also under development is a pulsating combustion system utilizing gaseous fuel for heating purposes. The only products of combustion are water and carbon dioxide which, in a normal system, could be carried off by ½-in. plastics hose, eliminating the need for a stack or flue.

who's doing what . . . A. R. Salzer, T. A. Stokes, G. A. Hero, J. E. Leininger and H. N. Stall have been appointed to a committee to study the portion of the New Orleans Building Code applicable to stacks and flues. Randy Lewis has been appointed Chairman of the Chapter's Technical Research Committee.

EVANSVILLE . . . Speaker at the December 6th meeting was Paul Upchurch of Texas Instruments, who showed a film of his company's plant.

SOUTHERN CALIFORNIA . . . Host for a tour of Young's Market meat processing plant, conducted as part of a recent meeting, was William Young, owner of the plant. Of special interest were the aging rooms, where shrinkage has been reduced almost half, due to a new low velocity air handling system which distributes conditioned air through two-in. diam holes in the ceiling.

RICHMOND . . . Speaking at a recent meeting, David Rickelton, Engineering Consultant, Buensod-Stacey Corporation, discussed "Design and Applications of Double Duct High Velocity Systems."

"Plastics Pipe and Its Future in Air Conditioning and Heating" was the topic of William E. Enright, Sales Director of Glamorgan Plastics Division, Glamorgan Pipe and Foundry Company, guest speaker at the December meeting.

ROCHESTER . . . Points to be considered when comparing electric and steam absorption refrigeration were highlighted by December guest speakers William Hill of Trane Company and Dean Johnson of Rochester Gas & Electric. The absorption cycle was described by speaker Hill.

NEBRASKA . . . Members of a panel meeting at the December 13th session to discuss "Base Bid Specifications" were Wray M. Scott, Wray M. Scott Company, Inc., representing mechanical contractors; Willis Regier, representing the architect; Ray Alvin, Leo A. Daly Company, Inc., representing the engineers; Roger D. Anderson, Anderson Brothers Engineering Company, representing suppliers; and Kenneth Martin, American Blower Company, moderator.

CENTRAL MICHIGAN . . . Projects which have been undertaken by the ASHRAE Laboratory were detailed at the December 13th meeting by C. M. Humphrey, Assistant Director of the Laboratory. Among those to which reference was made are studies of environment, heat transfer through fenestrations (conducted by use of a solar calorimeter through various types of window protectors), entrance infiltration, sound (especially in the realm of equipment noise), odor (specifically: acid, ciga-

rette smoke and kitchen odors), human calorimeter and steam flow through small copper tubing.

Also covered was the cooperative research program being carried out with the facilities of leading universities. Current projects are: University of Arizona, noise in liquid flow systems; Kansas State University, heat transfer of condensing refrigerant in horizontal and inclined tubes and heat transfer from air conditioning ducts; Case Institute of Technology, heat and mass transfer in dehumidifying process and model studies in air distribution; University of California, development of thermal circuit instrumentation for use in air conditioning problems and application of analogue techniques to solar collectors; University of Kentucky, influence of bubbling and rotational turbulence of the rate of boiling from a small cylinder immersed in liquid refrigerant; University of Minnesota, effectiveness and design of solar collectors; Pennsylvania State University, air sterilization by solid sorption dehumidifiers; University of Toledo, sterilization of air by liquid sorbents; and University of Pittsburgh, lateral exhaust ventilation.

FORT WORTH . . . In order to facilitate a projected change to a fiscal rather than calendar year basis for election of officers, it was decided that members taking office in January would serve but a six-month term. Nominated were Gerald F. Smith, President; James R. Blanke, Vice President; Les Tye, Secretary; H. E. Cunningham, Treasurer; and D. N. Reid, Thomas McMurry and C. L. Zahn, Board of Governors.

Program for the evening's meeting consisted of a film produced by Convair for the Air Force and public to give an insight into the country's defense program. Loyd Turner of Convair presented the film.

OREGON STATE COLLEGE . . . Low pressure boilers were considered at a recent meeting by Richard G. Farnes of Farnes Company.
who's doing what . . . Chapter President Charles Bullock reported that scholarships in the fields of heating and ventilating are being offered by the University of British Columbia.

CENTRAL ARIZONA . . . Discussed at the December 5th meeting by William S. Schock of Dow Chemical Company was the "History of Insulation." Included in the talk was a motion picture presentation of qualities of polystyrene foam insulation as applied to low temperature installations.

BRITISH COLUMBIA . . . Better environment for learning and teaching is provided by air conditioned schools, contended Maurice J. Wilson of Carrier Corporation, speaking at a recent meeting. Additionally, schools could then be used all year, without necessity for summer closing. However, he felt that a more economical design must be achieved. The modular concept was cited as giving appreciable savings, and several slides of schools designed in this manner were shown.
who's doing what . . . Ernest Neffer and Bruce Patrick are new members of this Chapter. Robert Malcolm, Chairman of the Social Events Committee, announced that James Williams has been added to the committee. Don G. Munro, speaking for the Research and Technical Committee, reported that the committee has under consideration a program of investigation of design temperatures in various areas.

ONTARIO . . . Elected to the Nominating Committee are: R. Ritchie, W. Smallwood, J. Thompson, C. L. Tory and L. N. Adams (ex-officio).
who's doing what . . . R. A. Stencil has been advanced to Life Membership of the Society.

IOWA . . . Gil Carlson of Bell & Gossett Company, guest speaker at the December meeting, presented a discussion on "Pump Location and its Pressure Effects on the Hot Water Heating System." Some highlights of the talk indicated that placement of the pump so that it discharges into the boiler (and the compression tank connected to the boiler) presents two problems: air may be drawn into the system, resulting in venting problems and corrosion, and the boiler may be subjected to pressure above the design or pop valve setting. More acceptable practice is to connect the compression tank to the boiler and the pump away from the boiler. For proper air separation, the water velocity should be reduced to ½ fpm or less. Also considered was the importance of proper pump selection.

LOUISVILLE . . . Much of air pollution is due to combustion, according to Arthur Stern, head of the Laboratory of Engineering and Physical Sciences, Division of Air Pollution, U. S. Public Health Service, guest speaker at a recent meeting. Indicating that coal, oil and gas will still be the major sources of heat and power in the next twenty years, he stated that as more fuel is burned, more pollution will be produced, unless better control is exercised.

States and communities are issuing regulations covering air pollution. Earlier ordinances were based on a fixed amount of pollution allowed per unit of fuel burned, and more recent regulations recognize the fact that larger plants can operate more efficiently and are more strict with them.

The 1960-61 Technical Seminar Program opened with a three-part presentation of "Filter Performance Evaluation." John D. Harms, American Air Filter

CHAPTERS REGIONAL COMMITTEE
MEETINGS AND CONFERENCES

REGION II, Quebec Chapter (Quebec), May 12 (Meeting)
REGION VIII, Shreveport Chapter (Shreveport), April 21-22 (Conference)
REGION IX, El Paso Chapter (El Paso), April 24 (Meeting)
REGION X, Central Arizona Chapter (Phoenix), April 28-29 (Conference)

Company Research Engineer, headed the discussion.

First part of the program covered techniques for evaluating the ability of a filter to remove particulate matter of a size greater than one micron. This includes most particles which have a tendency to settle. Resulting measurement is expressed usually in terms of percent of matter removed and is classified as a weight method.

Foreign matter of size less than one micron was covered next. Particles such as these usually float away, causing staining of walls and ceilings. A measured quantity of air is drawn through porous paper discs before and after filtration and, by optical means, the opacity is compared. This is referred to as the dust spot method or, in general terms, an area method.

Used for determining the effectiveness of high performance filters is the count method, where the particles themselves can be counted by use of the light scattering principle. To define successfully overall filter performance, each of these methods should be utilized, however, in most cases the first two are adequate.

NATIONAL CAPITAL . . . "Gas Air Conditioning in the Sixties" was reviewed by Bert Nye of Washington Gas Light Company at the December meeting.

NEW MEXICO . . . Fred Janssen, Region IX Director, spoke on reorganizational aspects of ASHRAE at a recent meeting.

who's doing what . . . Roger Haines has been nominated for membership on the Psychrometric Committee. Frank Bridgers, Peter Lujan, Marcello Giomi and Charles Davis have been appointed to a Code Committee to work with the Albuquerque Building Department on an air conditioning and evaporative cooling code.

CENTRAL NEW YORK . . . ASHRAE President Walter Grant was present at the December meeting to report on the long range research program, detailing work which will be carried out in private institutions, universities and private laboratories.

Herbert Cook moderated the program, a discussion of contracts. Principal speakers were William Hasselberger, President of Steele Piping Corporation, who spoke on the relationship of the contractor and subcontractor; Felix Laine, President of Myers-Laine Corporation, who covered separation of contracts; and Bryce Tuttle of Air Contracting Company, who discussed specialization in the mechanical contract.

EVANSVILLE . . . With the aid of photographs, Jack Franklin of Alco Valve Company, January speaker, described the function of thermostatic expansion valves. Use of external and internal equalizing-type valves was covered and operations of cross-charged, solenoid, suction line, evaporator pressure control, pilot-operated expansion and reversing valves were detailed.

DALLAS . . . Some obligations of a contractor to the owner and engineers, as outlined by George Linskie of the George Linskie Company at a recent meeting, include responsibility for holding progress meetings, scheduling deliveries to fit the progress of the job and inspection of the work. Mechanical contractors, he stated, are advocating bid separation. Further requirements of the contractor include communication with all involved, manning the job properly, making purchase orders as complete as possible and following up to see that equipment is available when needed.

who's doing what . . . Stanley A. Gray submitted a report on air conditioning of schools, on which he, Alan Smith and Oliver Erickson will report later with recommendations to be passed on to the Dallas School Committee.

ATLANTA . . . "Industrial Development–Georgia's New Frontier" was the topic of Dr. W. S. Buckingham of Georgia Institute of Technology, speaker at the December 12 meeting.

JOHNSTOWN . . . Films shown at the December meeting were "The Plastics Home of the Future," produced by Monsanto Chemical Corporation, and "Building Quality into American Homes," contributed by Crane Company.

CINCINNATI . . . Present at the December 6th meeting as a special guest was James H. Downs, Region V Director. Prior to the technical session, he gave a brief talk on problems encountered at the National level, some of which were cited as being related to the merger.

Jean R. Fortier, Senior Engineer with Westinghouse Electric Corporation in Youngwood, Pa., presented a slide-illustrated discussion of "Thermoelectric Refrigeration." He outlined several applications for this field, such as in missiles, where cost of refrigeration is secondary and condensed size of the mechanical equipment a primary consideration.

who's doing what . . . Chapter past-President Walter Rieger has agreed to serve as Chairman for the local United Engineering Center Building Fund Drive.

Moderating a panel discussion at the January 3rd meeting was Carl P. Krantz, who gave the educational and professional backgrounds of the panel members, Trevor Reiley of Johnson Service Company, Robert Hoeffer of Minneapolis-Honeywell Corporation and William Stevens of Richard Equipment Company. Subject of the discussion was "Temperature Control Equipment."

Pneumatic controls were discussed by Trevor Reiley with respect to initial cost, dependability, accuracy and maintenance. Emphasizing these same factors, speaker Hoeffer covered electrical controls. William Stevens reviewed the development of electronic controls and their application in the space program, as well as in heating, air conditioning and refrigeration.

who's doing what . . . Carl P. Krantz has been appointed Chairman of the Nominating Committee. Other committee members are Floyd N. Thompson, Trevor Reiley and T. D. Stikeleather. Walter Rieger presented plans for the UEC Building Fund Drive.

News of ASHRAE members

(*Continued from page 95*)

representative of these two societies on ASA Committee Z24, Sound and Vibration.

James A. Cain, Atlanta Division manager for A. M. Byers Company, retired November 30 after almost 18 years of service. Joining the company in 1942, he has been field service engineer, assistant Pittsburgh Division manager and Atlanta Division manager.

H. H. Baxter, after 34 years with Iron Fireman Manufacturing Company, has retired. Joining the company in 1927, he first worked on loan with L. R. Teeple Company as Shop Superintendent and then, in 1928, was transferred to Cleveland. Since 1945 he has supervised the electronic controls department, serving as liaison man between Iron Fireman's Heating and Air Conditioning Division in Cleveland and Signet Controls operation in Portland.

Carroll M. Baumgardner has retired as Director of National-U. S. Sales, a division of Crane Company, after 44 years in the heating and air conditioning industry. Beginning his career in 1916 with U. S. Radiator Corporation, he was associated with that company until 1948, serving in sales and administrative capacities, including those of Executive Vice President and President of the Pacific Boiler and Capital Finance Divisions. He joined National Radiator Company in 1948 as Vice President of Sales, and since 1955 has served as Senior Vice President of Sales, Director and Member of the Executive Committee of the Board. A member of ASHRAE and precedent ASHVE since 1928, he is past-Chairman and Director of the Institute of Boiler and Radiator Manufacturers; former Director of Steel Boiler Institute, Plumbing and Heating Industries Bureau of Chicago; and Vice President and Director of the Better Heating-Cooling Council.



Necrology

Charles L. Dugan, past-Secretary of Florida West Coast Chapter, died recently. He had worked for Krauss Air Conditioning; Reynolds, Smith & Hills; and Charles T. Healy Consulting Engineers.

Abe Corbman, founder and President of Adelts Manufacturing Company, Inc., died November 23, 1960, at the age of 62.

Thomas J. Ryan, Executive Vice President of the Mechanical Contractors Association of America, died in the collision of two airplanes over New York City on December 16, 1960. An expert on labor law and legislation, he came to MCAA as Executive Secretary in 1959, from his post as Assistant General Counsel of the National Labor Relations Board. He was elevated to the Executive Vice Presidency in May, 1960.

Lawrence D. Chellis, Mechanical Engineer with the U. S. Army Quartermaster Corps, died recently at the age of 60. A 1921 graduate of Massachusetts Institute of Technology, he had been a member of the former ASRE since 1947. From 1949-50 he was Chairman of the Program Committee of Boston Chapter and, in addition, had served on the Membership, Nominating and Hospitality Committees.

John H. Blake was a partner in the firm of E. P. Sheldon & Son at the time of his recent death. A graduate of Brown University, he joined the Society in 1958.

Everett R. Benedict, deceased, had retired as President of Durant Insulated Pipe Company, Inc., last year. Prior to that, he had been Vice President of the Ric-wiL Company.

Andre Nessi, President of Nessi Brothers, Paris, France, died recently. He had been a member of the former ASHVE since 1948.

BULLETINS

(*Continued from page 71*)

air-cooled unit suitable for field use—3⅞-in. stroke; four, five and six stages; and capacities to 150 cfm.
Clark Brothers Company, Div of Dresser Industries, Inc., Olean, N. Y.

Warm Air Heater. Requiring a minimum of floor space, Thermobloc heaters can, where conditions require, be hung from walls or ceiling suspended. Gas and oil are used for fuel, and combination burners are available that permit changeover from one fuel to the other automatically.

Dimensions, specifications, product illustrations and schematic drawings are presented in an eight-page bulletin. A variety of installations are pictured.
Wanson Corporation, Charles and Juniata Sts., Lewistown, Pa.

Product Line. Described and illustrated in four-page Bulletin 31F are representative models in the Kno Draft lines of linear, square, rectangular and circular ceiling air diffusers, grilles and registers, high velocity equipment and the Dorex line of air recovery and purification cells and cannisters. Design and function advantages are detailed.

Recent additions to the line of rectilinear diffusers—Type KO perforated and Type KSS vari-pattern — are introduced. Featured is Pneumavalve, a motorless, pneumatically-actuated air flow regulator capable of low, medium or high velocity system application. Also presented is a new Dorex Type G high velocity air purification panel.
Connor Engineering Corporation, Danbury, Conn.

Pin Welder. Spotting of insulation pins to ductwork can be accomplished now with two new units discussed in a four-page bulletin. Pins, designated Spotter Pins, are supplied in standard lengths from ¾ to 2½ in. To spot a pin, it is first inserted in the electrode tip. Unit is depressed against the work and a switch is pressed. Automatic timing is cited as insuring uniform, secure welds.

Model PS-100 weighs only 25 lb and works on 110 volt. It can be carried to the work or suspended over the work area. Model PS-200, a 220-volt unit, offers the added flexibility of a remote gun connected to the 30-lb power source by five-ft cables.
Duro Dyne Corporation, Rte. 110, Farmingdale, N. Y.

Candidates for ASHRAE Membership

Following is a list of 98 candidates for membership or advancement in membership grade. Members are requested to assume their full share of responsibility by the acceptance of these candidates for membership by advising the Executive Secretary on or before February 28, 1961 of any whose eligibility for membership is questioned. Unless such objection is made these candidates will be voted by the Board of Directors.

Note: * Advancement † Reinstatement

REGION I

Connecticut

HARRIGAN, D. P., Engr., Hill & Harrigan, New Haven.
OLSON, N. H., Sales Engr., John J. Nesbitt, Inc., East Hartford.

Massachusetts

CHASE, K. D., Sr. Mech. Engr., Sylvania Electronic Systems, Needham.
LANEN, T. A., Sales Engr., L. C. Pelkus & Co., Inc., Wellesley Hills.
SOVA, C. R.,* Owner, Modern Heating & Vent. Co., Gloucester.

New Jersey

LICHTENSTEIN, MARK,* Proj. Engr., Kramer Trenton Co., Trenton.
WERNER, P. H.,* Self Employed, Newark.

New York

BRINKERHOFF, W. J., Appl. Engr., Dunham-Bush, Inc., New York.
COHEN, ALLEN, Sales Engr., York Corporation, New York.
JOHNSON, J. W., Sales Engr., Pres., Air Handling Equip. Corp., Syracuse.
KOVAL, R. M., Engr., Jaros, Baum & Bolles, New York.
KOWADLO, LEONARD,* Engr., J. T. Falk & Co., Inc., New York.
LUND, J. J.,* Development Engr., Hi-Press Air Conditioning of America, Inc., Long Island City.
MARCUS, HENRY, Vice-Pres., Queens Metal Fabricators, Inc., Manhasset.
MCRAE, W. M. JR., Sales Engr., Powers Regulator Co., Rochester.
OLESKO, T. S.,† Mfg. Agent, Albany.
RONN, BENJAMIN, Engr., Slant/Fin Radiator Corp., Richmond Hill.
WATSON, K. C., Mfg. Repr., Marcellus.

Rhode Island

GAGNON, RAOUL, Asst. Engr., Halliwell Eng. Assoc., Warren.

REGION II

Canada

CHARLEBOIS, J. L.,* Sales Engr., Carrier Corporation, Montreal, Que.
CONWAY, JACK, Engr. & Estimator, Waterman-Waterbury Co., Ltd., Regina, Sask.
DWARTE, R. B., Prod. Engr., Dunham-Bush (Canada), Weston, Ont.
HOVINGH, JOHN, Design & Appl. Engr., Roy Soderlind & Co., Ottawa, Ont.
NAGEL, G. H., Sales Repr., Waterloo Mfg. Co., Ltd., Waterloo, Ont.
SMYTH, D. A., Design Draftsman, Kelmar Construction Co. (Toronto Industrial Leaseholds), Weston, Ont.
TASCHEREAU, EDMOND, Sales Engr., Sheldons Eng. Ltd., Montreal, Que.

REGION III

Maryland

CLARK, C. B., Sr. Engr., Martin Company, Baltimore.
CLIFFORD, F. C. JR., Vice-Pres., F. C. Clifford, Inc., Baltimore.
KNABE, L. C. JR., Mech. Design Engr., Henry Adams Inc., Baltimore.

Pennsylvania

MCCLINTOCK, W. W., Sales Engr., Bryant Air Conditioning Corp., Philadelphia.
MEINEL, G. S., Sales Engr., York Corporation, Philadelphia.

Virginia

BROWN, L. W. JR., Sales Repr., Automatic Equipment Sales of Norfolk, Inc., Norfolk.
JULIAN, H. H., Engr., James E. Hart, Norfolk.
REED, B. A., Designer, James E. Hart, Norfolk.
WEBB, W. M., Sales Engr., Shultz & James Inc., Norfolk.

West Virginia

PRICE, D. E., Instructor Mech. Engr., West Virginia Institute of Technology, Montgomery.

REGION IV

North Carolina

AGNEW, R. G.,* Partner, Mechanical Engineers, Inc., Charlotte.
KIRKMAN, J. W., Estimator & Designer, Dick & Kirkman, Inc., Greensboro.
MONTAGUE, B. L., Proj. Engr., Hackney Bros. Body Co., Wilson.
PAYNE, G. N. JR.,* Engr., Mechanical Engineers, Inc., Charlotte.

REGION V

Ohio

CLAUSEN, PETER, Owner, Peter Clausen & Co., Cleveland.

REGION VI

Illinois

COATES, R. E., Mgr., Knickerbocker Sheet Metal Co., Chicago.
CURNYN, P. J., Design Engr., Vern E. Alden, Chicago.
WALKER, R. E., Mgr., Pacific Steel Boiler Division of Crane Co., Chicago.

Iowa

RETRUM, ROWLAND, Mgr. Engrg., The Rath Packing Co., Waterloo.
WILLIAMS, R. L., Repr., Minneapolis-Honeywell Reg. Co., Davenport.

Minnesota

BILLING, O. D., Mech. Engr., Bergstedt, Hirsch, Wahlberg & Wold, St. Paul.

Wisconsin

DOWNEY, P. F., Pres., Downing Heating Co., Milwaukee.
HANING, C. F., Designer, Lofte & Fredericksen, Milwaukee.
NEZWORSKI, J. E., Design Engr., The Perlick Co. Inc., Milwaukee.
YANZ, J. W., Estimator, Downing Heating Co., Milwaukee.

REGION VII

Alabama

BENTLEY, T. F., Chief Engr., Piping Engineering & Contracting Co., Inc., Mobile.
BROWN, H. B. JR., Mfg. Agent, Birmingham.
CARROLL, J. H. JR., Tech & Sales Repr., Worthington Corp., Birmingham.

Kentucky

ROY, K. J.,* Partner, Carr, Roy & Assoc., Louisville.

Louisiana

FOURNET, L. P., Asst. Mech. Engr., Bodman & Murrell & Smith, Baton Rouge.
PRATHER, B. C.,† Owner, Prather Refrigeration Co., Morgan City.

Mississippi

CARTER, W. O., Mech. Designer, Pritchard & Nickles, Tunica.
GURAEDY, J. L., Engr., United Gas Corp., Jackson.

REGION VIII

Oklahoma

NICHOLS, J. K., Sr. Engr., Natkin & Co. of Okla., Tulsa.

Texas

TRUITT, R. R., Div. Sales Repr., Texas Electric Service Co., Midland.
WALSH, J. A.,† Pres. & Gen. Mgr., J. A. Walsh & Co., Houston.

REGION IX

Kansas

BEYER, K F., Lab. Tech., The Coleman Co., Inc., Wichita.
CHAN, M. K., Mech. Engr., The Coleman Co. Inc., Wichita.
SAGE, R. W. JR., Tech. Administrator, The Coleman Co., Inc., Wichita.

Nebraska

WHITNEY, D. E., Engr., Natkin & Co., Lincoln.
WRENN, P. B., Sales Engr., Johnson Service Co., Omaha.

Utah

IRVINE, D. K., Repr., Utah Lumber

Co., Salt Lake City.
LARSEN, S. L., Vice-Pres. Gen. Mgr., The P. L. Larsen Co., Provo.
MORGAN, J. D., Repr., Utah Pioneer Corp., Salt Lake City.
SMITH, C. G., Design Engr., Smith & Needham, Salt Lake City.

REGION X

Arizona

JONES, J. P. III, Cons. Engr., Tucson.
MESSER, T. I., Owner, Theodore Messer, Phoenix.

California

ANDERSON, P. Z., Engr., Preco Incorporated, Los Angeles.
BRIDWELL, G. L., Constr. Repr., J. C. Penney Co., Inc., Los Angeles.
BRUKIEWICZ, PETER, Proj. Engr., National Refrig. Sales, Los Angeles.
CATTON, T. R. III, Sales Engr., Tennity & Co., Inc., Los Angeles.
CHAMBERS, G. B.,* Jr. Engr., Transicold Corp., Montebello
EHRMANN, S. L., Mech. Engr., John Denton, Los Angeles.
GRAHAM, M. M., Engr. Supervisor, Grayson Controls Div. Robertshaw-Fulton, Long Beach.

Long Beach

GORHAM, W. S., Br. Mgr., Ilg Electric Ventilating Co., San Francisco.
TOMKINSON, S. L., Proj. Engr., Monrovia Aviation Corp., Monrovia.
WARNE, R. J., Bldg. Supt., Adolph's Ltd., Burbank.

Oregon

THORNBURGH, G. E., Asst. Prof., Oregon State College, Corvallis.

FOREIGN

Africa

DIXON, M. R., Inspector of Works, Public Works Dept. of Sierra Leone, Freetown, Sierra Leone.

Australia

CROCKFORD, G. C., Self Employed, Crockford & Robertson Pty., Ltd., Fairfield, Victoria.
ROBERTSON, S. B., Technical Sales Director, Crockford & Robertson Pty., Ltd., Fairfield, Victoria.

England

ECCLESTON, W. H., Sr. Htg. Engr., J. G. L. Paulson, Westminster, London.
WILKINSON, IAN, Sr. Design Engr., Hinton Jones (Engineers) Ltd., London.

Italy

SCHRAEMLI, JACQUES, Tech. Mgr., Societa Italiana per Impianti, Frigoriferi, Milan.

India

HUKMANI, N. S., Asst. Engr., Voltas Ltd., Bombay.
PATEL, D. R., Proj. Engr., American Refrigerator Co., Bombay.

Mexico

MICHEL, ROBERTO, Mgr., Jesus R. Gomez H., Leon, Guanajuator.

United Arab Republic

EL-KAMAH, H. M., Chief Engr., Ministry of Public Works, Mechanical & Electrical Dept., Cairo.

Venezuela

RUBADO, J. C., Chief Field Engr., EMCA Tecnica Air Conditioning & Refrigerating, Caracas.

West Pakistan

ALVAREZ, L. J., Chief Mech. Engr., Greer Boutwell Inc., Kharian Cantonment.

Students

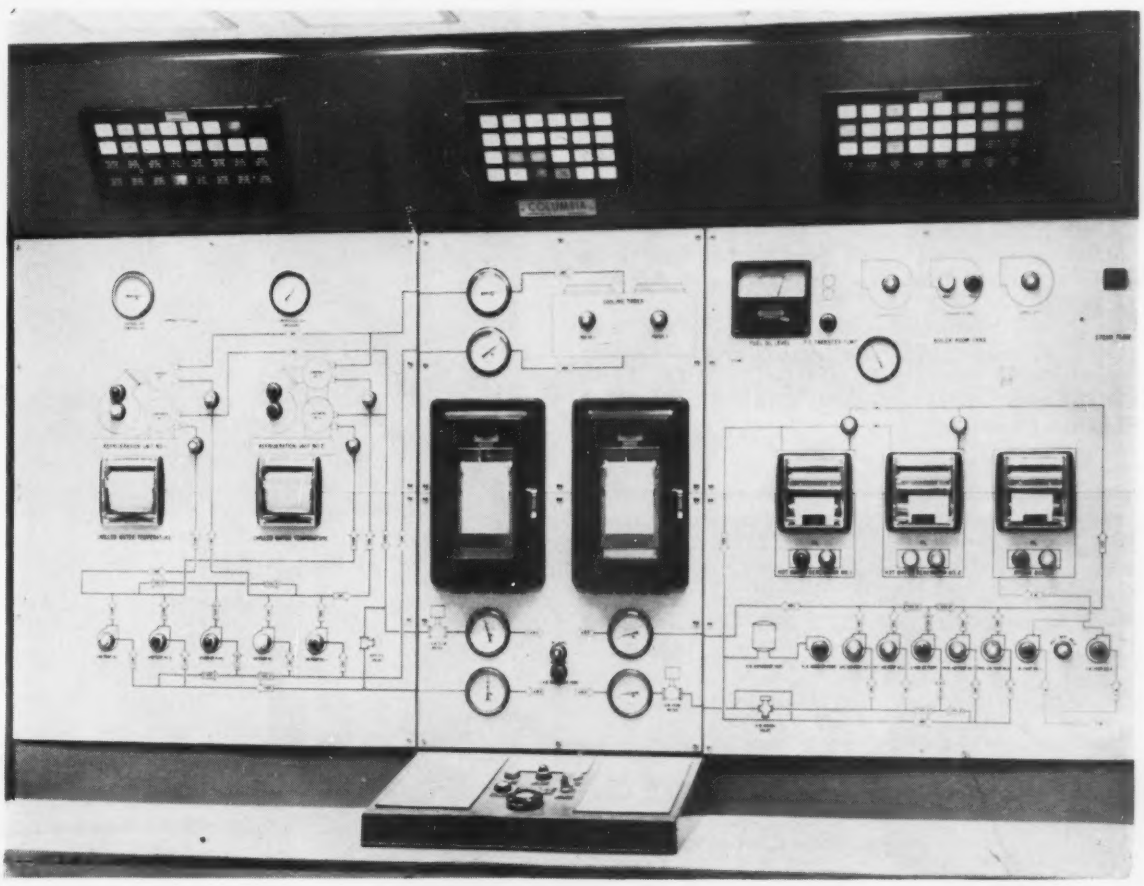
BUDDE, V. B., University of Kentucky, Lexington, Ky.
MONTGOMERY, R. A., University of Kentucky, Lexington, Ky.

Daily Data Pace Cooling-Heating Demands

Neatly centralized at the control desk for a West Coast one-company office building, these controls and supervisory meters have been devised with anticipated equipment loading matching chilled water or hot water demands as the design objective.

The air conditioning system is largely freed of emergency start ups. The Btu meters provide chart recordings of usage which are coordinated with the chilled water output temperature recordings and similar data for the steam boiler and two hot water generators for operational analyses.

Air Conditioning Equipment Corp.



ASHRAE-UEC Campaign Moves Into Second Gear

At long last, the ASHRAE-UEC Fund Raising Campaign has moved slowly into second gear. As of January 4th, 44 Chapters had taken definite action to fulfill their assigned quotas. This is an increase of 12 more Chapters over the number reported in the January issue of the JOURNAL. As of December 30, ASHRAE had raised $29,450.90 towards its pledge of $250,000.

Here are the 44 Chapters which, thus far, are cooperating in this drive:

REGION I — New York, North Jersey, Northeastern New York, Northern Connecticut, Rochester and Southern Connecticut.

REGION II — Manitoba, Northern Alberta, Ottawa Valley and Ontario.

REGION III — Johnstown, Philadelphia, Pittsburgh and Richmond.

REGION IV — Savannah, North Piedmont, South Carolina and South Piedmont. (The latter Chapter has already achieved and exceeded its quota.)

REGION V — Cleveland, Columbus, Toledo, Cincinnati, Dayton and Evansville.

REGION VI — Illinois, Iowa, Minnesota and Western Michigan.

REGION VII — New Orleans, Baton Rouge, Mobile, North Alabama and Memphis.

REGION VIII — Central Oklahoma and Northeastern Oklahoma. (The former Chapter has already achieved and exceeded its quota.)

REGION IX — Nebraska, Rocky Mountain, Utah and New Mexico.

REGION X — Oregon, Central Arizona, Golden Gate, Southern California and Tucson.

As of June 30, 1960, following the Society's Annual Meeting in Vancouver, the total funds raised for the ASHRAE-UEC drive were $23,927.00. Now, on the brink of the 1961 Semiannual Meeting in Chicago, our contributions have increased by only $5,523.90.

If your Chapter hasn't yet organized its fund raising campaign, offer your services and help solicit contributions. Better still, MAIL IN YOUR CONTRIBUTION TODAY, LET'S MAKE GOOD OUR PLEDGE IN 1961.



NAME .....

ADDRESS .....

IN CONSIDERATION OF THE GIFTS OF OTHERS INTENDS TO GIVE TO

UNITED ENGINEERING CENTER BUILDING FUND

.....DOLLARS $.....

BALANCE TO BE PAID QUARTERLY $....., SEMIANNUALLY $.....

ANNUALLY $....., OR AS FOLLOWS .....

SIGNED.....

MEMBER ASHRAE

CHECK MAY BE MADE PAYABLE TO UNITED ENGINEERING TRUSTEES, INC.
29 WEST 39TH STREET, NEW YORK 18, N Y.
GIFTS ARE DEDUCTIBLE FOR INCOME TAX PURPOSES

McQuay

air conditioning equipment

Including the New Single and Multi-Zone Air Handling SEASONMASTERS

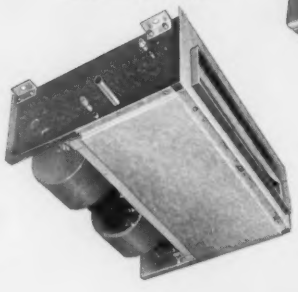
McQuay Means Quality



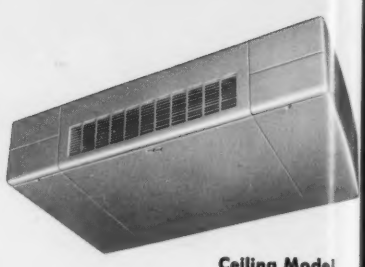
McQuay

SEASONMAKERS

McQuay offers the finest in remote type, individual room air conditioners for use with a central station heating and cooling system. Extremely quiet, the "Seasonmaker" is available in floor, basic, ceiling and hideaway models in a wide range of sizes to meet your exact requirements. Floor and basic models range from 220 to 1240 cfm, and ceiling and hideaway models range from 220 to 640 cfm. Write for catalog 715.



Hideaway Model



Ceiling Model



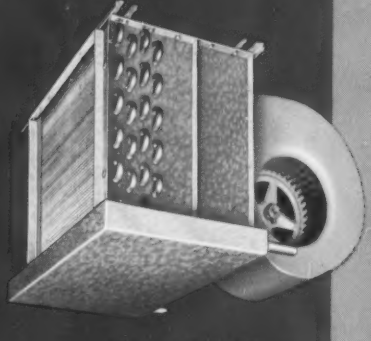
Floor Model



Basic Model



Ceiling Model



Hideaway Model

LARGE CAPACITY SEASONMAKERS

2 TO 10 TONS CAPACITY

Remote type ceiling suspended air conditioners for medium to large areas. Designed for fully recessed closet and false ceiling installations, or horizontally suspended in the conditioned space. The quiet, attractively styled McQuay large capacity "Seasonmaker" is available in four sizes of direct drive and five belt driven models. Write for catalogs 722 and 730.

McQuay



Vertical Air Flow Aircon



Horizontal Air Flow Aircon



"AL" Aircon

REMOTE TYPE AIR COOLED CONDENSERS

"AB" AIRCONS—Propeller fan types available in either horizontal or vertical air flow. Thirteen sizes each from 8 to 85 tons nominal capacity. Multiple installations make capacity unlimited. Write for catalog 629.

"AL" AIRCONS—Centrifugal fan types are designed for outdoor or indoor installations with or without duct work. They may also be used for exhaust ventilation and heating. Compactly engineered with a low silhouette, there is a wide range of unit and fan discharge arrangements. Write for catalog 635.

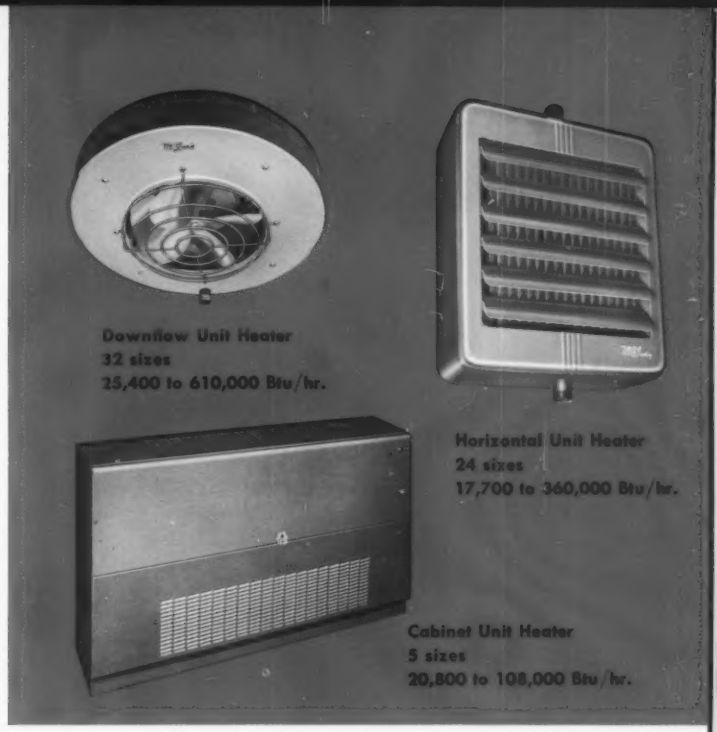
AUTOMATIC HEAD PRESSURE CONTROL

The McQuay type "AB" and "AL" Aircons are available with air side and refrigerant side head pressure control. The "AB" line is offered with opposed blade face dampers and corresponding controls for automatic operation.

McQuay

UNIT HEATERS

Horizontal, downflow and cabinet type unit heaters are available in an exceptionally wide range of sizes and capacities for either steam or hot water. Adjustable louvers and several varied styles of air deflectors are available. McQuay cabinet type unit heaters are available for floor, wall and ceiling applications; for exposed, semi-recessed or fully recessed installations. Write for horizontal unit heater catalog 323, downflow unit heater catalog 765, cabinet unit heater catalog 351.



Downflow Unit Heater
32 sizes
25,400 to 610,000 Btu/hr.

Horizontal Unit Heater
24 sizes
17,700 to 360,000 Btu/hr.

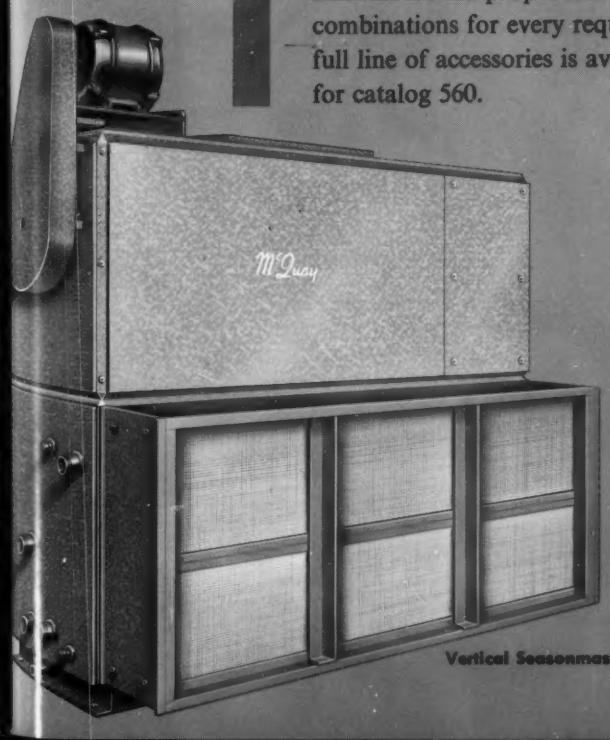
Cabinet Unit Heater
5 sizes
20,800 to 108,000 Btu/hr.

McQuay

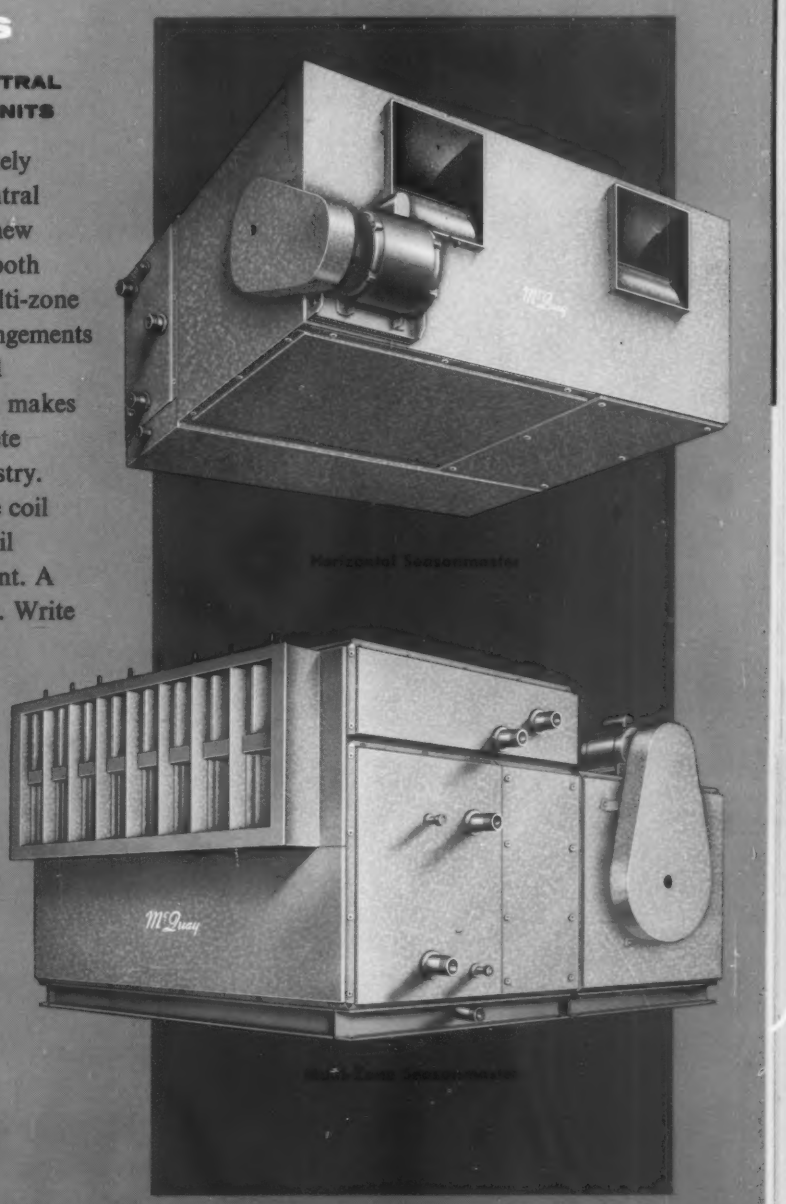
SEASONMASTERS

SINGLE AND MULTI-ZONE CENTRAL STATION AIR CONDITIONING UNITS

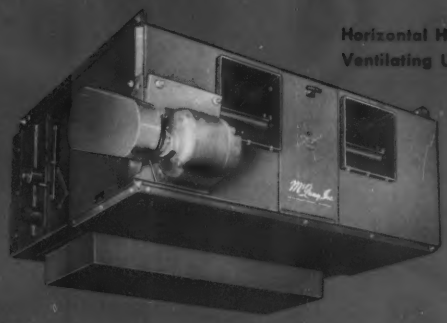
McQuay proudly offers a completely new line of quality engineered central station air conditioning units. A new space saving design, available in both single zone draw through and multi-zone or double duct blow through arrangements in low pressure (up to 3″ s.p.) and medium pressure (3″ to 5½″ s.p.), makes the McQuay line the most complete and versatile throughout the industry. Twenty-four models with multiple coil sizes insure the proper fan and coil combinations for every requirement. A full line of accessories is available. Write for catalog 560.



Vertical Seasonmaster



McQuay



Horizontal Heating and Ventilating Unit



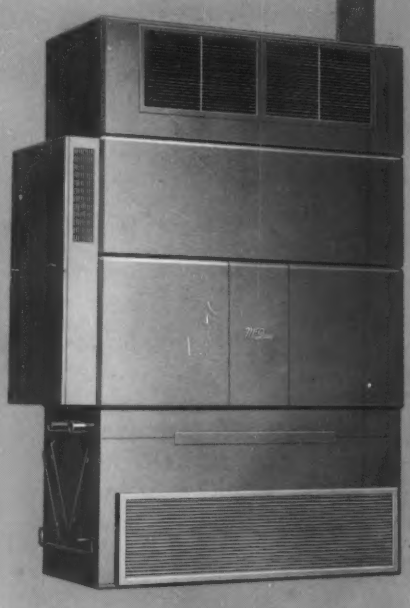
Vertical Heating and Ventilating Unit

"HC" HEATING AND VENTILATING UNITS

For heating and ventilating, McQuay offers the most flexible line available anywhere. Designed for horizontal, vertical, wall and inverted installations for use with or without duct work to fill the needs of every installation. For use with hot water or steam, the McQuay line offers the widest range of coil selection in the industry, with capacities ranging up to 48,000 cfm and 3,320,000 Btu/hr. Write for catalog 344.

McQuay

SEASONVENT



The McQuay Seasonvent is a deluxe large capacity heating and ventilating unit engineered specifically for school auditoriums, theatres and similar installations where quiet operation is a necessity. The Seasonvent is extremely versatile with nine sizes for low static applications (0" to 1¼" s.p.) and seven sizes for high static installations (1" to 2" s.p.), with capacities from 1250 to 15,000 cfm. Write for catalog 575.

McQuay

RIPPLE-FIN COILS

By the Nation's Largest Coil Manufacturer

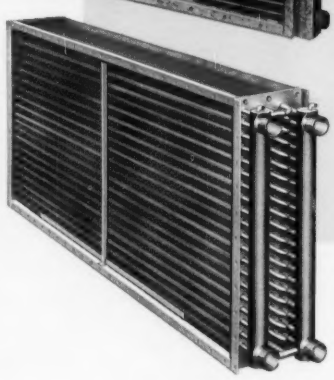
A new type "5" coil design with a wide range of available fin spacings offers unlimited selection to meet all load requirements. This new design affords a new high in fin efficiency by attaining the highest heat transfer rate possible without excessive air friction. The combination of equilaterally staggered tubes and modified rippled fins produces maximum air turbulence, and intimate and prolonged contact between air and heat exchanger surface.



Direct expansion coils with pressure type distributors.



Pitched in casing steam coils. Easy installation and positive condensate draining.



Flow circuited water cooling and heating coils.

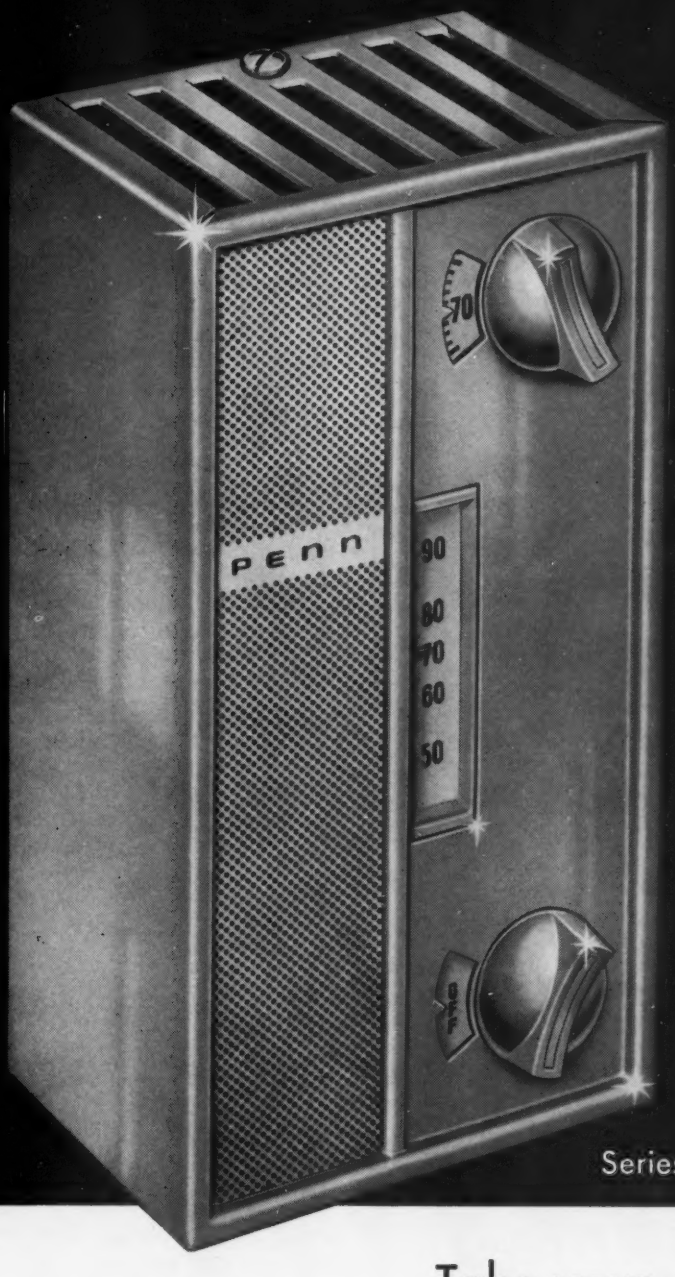
McQUAY, INC., 1600 Broadway N.E., Minneapolis 13, Minnesota

McQuay INC.

AIR CONDITIONING • HEATING • REFRIGERATION



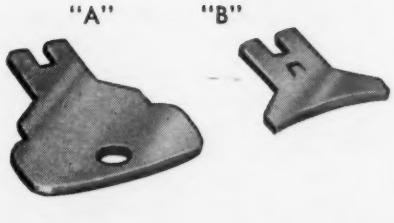
DM—1961-2 Printed in U.S.A.



NEW

line voltage THERMOSTAT with front panel control of all heating-cooling functions!

Series 822



How settings are locked

Where it is desirable to lock settings, installer removes cover and pushes out factory-installed key "B" from each adjusting knob. This disconnects knob from adjusting shaft. Then, user may insert special key "A" (supplied for key chain use) through knob slot and turn to make desired settings . . . remove key and thermostat is locked as adjusted.

Take your choice...heating, cooling or heating-cooling...each features unique, easy-to-use, locking-type knobs

Here's the line voltage thermostat that has "everything" desired for accurately controlling temperature in motels, schools, offices and similar installations.

It has easy-to-read temperature and function selector dials. It has an accurate bimetallic thermometer with vertical dial. It has exclusive, locking type adjusting knobs, attached to cover but connected to adjusting shafts by factory-installed "keys" within the knobs. It has a unique, built-in but concealed adjustable high limit stop for temperature dial. It has an unusually sensitive element and mechanism which provide low operating differential at all voltages and all amperages within its rating. It has easiest "field wiring" ever... simply connect to large terminals *on back of thermostat.* And, it has modern "thin-line", compact styling. Learn more about this new thermostat... write to the Penn factory for Bulletin 3233.

PENN CONTROLS, INC. Goshen, Indiana

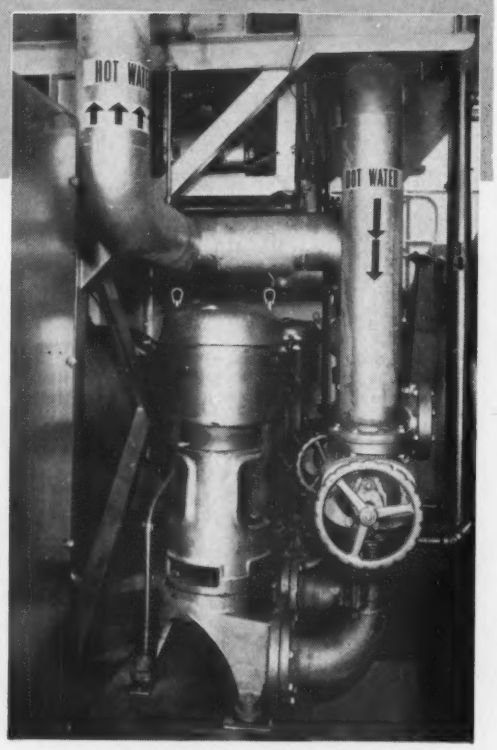
EXPORT DIVISION: 27 E. 38th ST., NEW YORK, N.Y.

AUTOMATIC CONTROLS FOR HEATING, REFRIGERATION, AIR CONDITIONING, APPLIANCES, PUMPS, AIR COMPRESSORS, ENGINES

SPECIFY THE weil

VKY Space Saving

VERTICAL CIRCULATING PUMP



for

CIRCULATING • HOT WATER FOR HEATING

CIRCULATING • CHILLED WATER FOR COOLING

CIRCULATING • CONDENSER WATER

BOOSTER • PUMP SERVICE

Capacities to • 750 GPM.

QUIET OPERATING
EFFICIENT PERFORMANCE
An all ball bearing pump designed for continuous operation!

THE weil VKY pump . . .

The highly efficient VKY PUMP requires only one shaft seal. Supply and discharge piping are on one side only. All operating parts may be removed without disturbing any piping connections. Motor is a standard frame NEMA C mount with standard shaft extension. Vibration is eliminated by three rubber vibration eliminator mounts. Noise transmission is reduced to an absolute minimum.

SEND FOR BULLETIN VKY-6900.

weil PUMP COMPANY

1536A N. Fremont St. • Chicago 22, Ill.

See the weil display in Booth 954-958 at the International Heating & Air-Conditioning Exp. Feb. 13th to 16th.

BULLETINS

Electric Water Heaters. Immersion units heat water directly rather than the air around them. Concentrated heat of these units will not injure the bottom of the tank as with fuel heaters. Glass lining of the tanks prevents rust. Fiber insulation surrounds top, bottom and sides of the tanks and is cited as permitting storage of hot water for as long as three days without reheating. A cold water baffle prevents cold water from mixing with hot. Four-page Bulletin J-30-CL provides product illustrations and diagrams, capacity and general descriptions.

Silverline automatic electric water heaters are the subject of four-page Bulletin G-31-CL. Calrod heating units circle the outside of the tank and are held in direct contact with the tank by spring tension. Automatic thermostats are adjustable from 120 to 180 F. Round heaters are available in 30, 40, 52 and 82-gal sizes, tabletop models in 30, 40 and 50-gal capacities.

Hotpoint Div, General Electric Company, 5600 W. Taylor St., Chicago 44, Ill.

Temperature Chambers. One to ten-cu ft units, designed especially for applications where temperatures from −150 to 300 F are required, are the subject of a four-page bulletin. Small capacity temperature chambers are illustrated, together with accessories and special controls.

Cincinnati Sub Zero Products, 3930 Reading Rd., Cincinnati 29, Ohio.

Gate Valves. Designed specifically for ductile iron, the Pipe-Pal series of ½ through 2-in. and Pipe-Mate series of 2 through 12-in. valves are covered in 12-page Catalog 1011. Featured on the smaller valves are spiral wound gaskets; larger units incorporate buttressed flange construction.

In addition to listing extensive engineering specifications, pressure-temperature ratings and testing data, the bulletin describes many applications of the valves. Included also is a description of the engineering properties of ductile iron and advantages it offers in the valve field.

Ohio Injector Company, Wadsworth, Ohio.

Hot Water Heating. Circulators, flow control valves, expansion tanks, air vent valves, air traps, pressure control units, pressure relief and reducing

LATEST MEMBER OF RBM **AIR CONDITIONING / REFRIGERATION** CONTROL FAMILY

NEW

25 AMP — 2 AND 3 POLE

CONTACTOR

TYPE 85

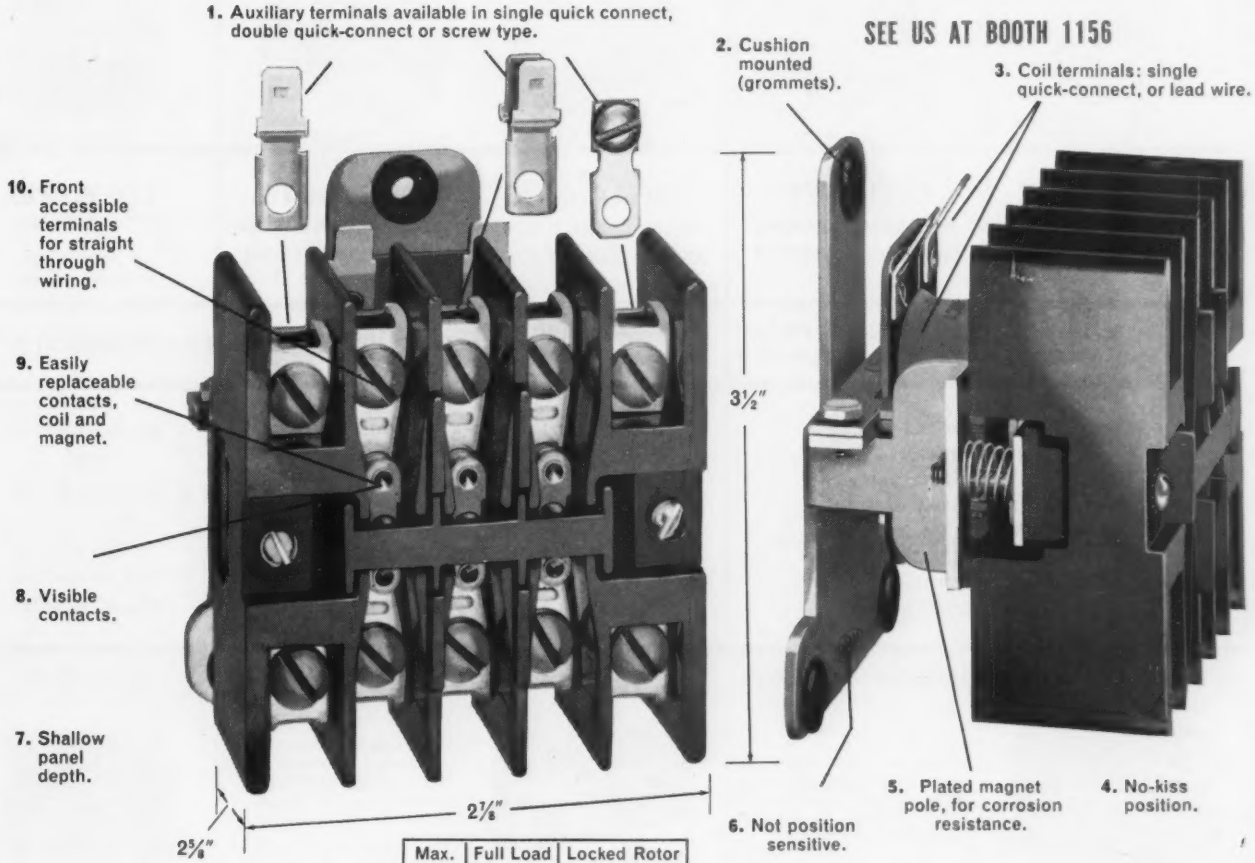
DESIGNED FOR U L AND CSA LISTING

Patent Pending

Simplifies panel circuitry — helps eliminate terminal boards — cuts wiring costs.

Here is the first air conditioning contactor designed so auxiliary terminals can be added to power wiring terminals. Also, extra dummy wiring terminals can be added when required. Such flexibility can help eliminate terminal boards, lower wiring costs, and provide more versatile and simplified panel circuitry. Auxiliary terminals can be #8 screw or ¼" single or double quick-connect. Dummy terminals are #10 screw with or without the auxiliary terminals. Consult your application engineer or write for Bulletin C16.

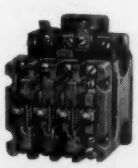
SEE US AT BOOTH 1156



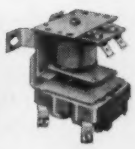
Max. Volts	Full Load Amps.	Locked Rotor Amps.
250	25	150
600	12.5	75

ONLY RBM HAS ENGINEERED A COMPLETE FAMILY OF AIR CONDITIONING CONTROLS

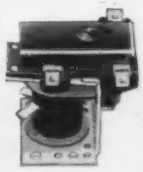




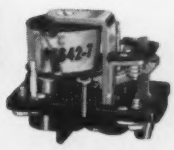
TYPE C-30, C-40, C-50 CONTACTORS Write for Bulletin 1070



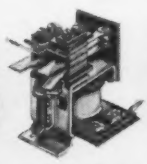
TYPE 80 CONTROLLER Write for Bulletin C-11



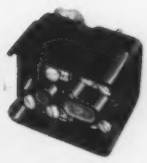
TYPE 75 POWER RELAY Write for Bulletin 1030.



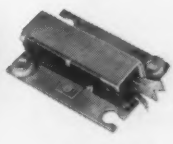
SERIES 129000 SHUNT TYPE RELAY—SPNO, SPNC OR NO-NC Write for Bulletin 1010-A.



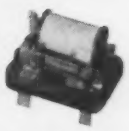
GENERAL PURPOSE RELAY Write for Bulletin 1060



SERIES 128000 POTENTIAL STARTING RELAYS Write for Bulletin 1010-A



BIMETAL TIME DELAY RELAYS AND THERMOSTATIC DEVICES Write for Bulletin C-15



ENCLOSED BANTAM RELAY TYPES 83 & 84 Write for Bulletin 1080

CONTROLLING RBM QUALITY THE FUTURE

RBM Controls Division

ESSEX WIRE CORPORATION, LOGANSPORT, INDIANA

Factories Located at North Manchester and Logansport, Indiana

Copeland® has what it takes!

ACCESSIBLE HERMETICS

AIR-COOLED



Model LAL-300

COPELAMETIC
ACCESSIBLE HERMETIC
MOTOR-COMPRESSORS

¼ H.P. THROUGH 3 H.P.
SINGLE AND THREE PHASE

COMMERCIAL REFRIGERATOR DISPLAY CASES
REACH-IN REFRIGERATORS
LOW-TEMPERATURE DISPLAY CASES
DAIRY PRODUCTS DISPLAY CASES
BULK MILK REFRIGERATION SYSTEMS
TRANSPORT REFRIGERATION
FROZEN FOODS PROCESSING
ICE-MAKING EQUIPMENT

WATER-COOLED

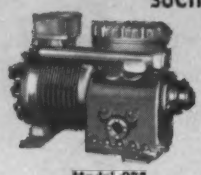


Model MAF-500

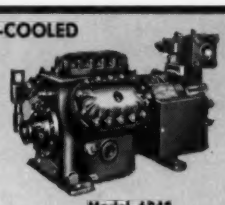
COPELAMETIC
ACCESSIBLE HERMETIC
MOTOR-COMPRESSORS

¼ H.P. THROUGH 7½ H.P.
SINGLE AND THREE PHASE

SUCTION-COOLED



Model 9R8



Model 6R48

COPELAMETIC
ACCESSIBLE HERMETIC
MOTOR-COMPRESSORS

2 H.P. THROUGH 10 H.P.
SINGLE AND THREE PHASE

COPELAMETIC
ACCESSIBLE HERMETIC
MOTOR-COMPRESSORS

7½ H.P. THROUGH 30 H.P.

COMMERCIAL REFRIGERATION UNITS, HIGH, MEDIUM AND LOW TEMPERATURE APPLICATIONS
UNITARY AIR CONDITIONERS AND HEAT PUMPS
ENVIRONMENTAL TEST EQUIPMENT
CENTRAL STATION WATER CHILLERS
GUIDED MISSILE TRACKING AND TELEMETERING EQUIPMENT COOLING

BELT-DRIVEN



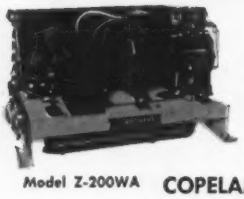
Model 18

COPELAND
COMPRESSORS
- AIR-COOLED
- WATER-COOLED

1/6 H.P. THROUGH 7½ H.P.

FOR REFRIGERATION
AND
AIR CONDITIONING
APPLICATIONS
WHERE VARYING
CURRENT CHARACTERISTICS
REQUIRE FLEXIBILITY

COMBINATION AIR AND WATER-COOLED

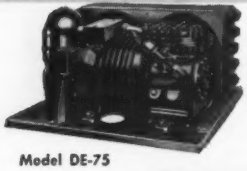


Model Z-200WA

For use where an air-cooled unit is desired, but high ambient temperature is encountered occasionally — or where water is limited or high priced.

COPELAMETIC
½ H.P. THROUGH 3 H.P.

SELF-CONTAINED, EXTRA-LOW HEIGHT



Model DE-75

These units are designed for special applications where height must be an absolute dimensional minimum.

COPELAMETIC
½ H.P. THROUGH 2 H.P.

TRUCK UNITS



Model TR-162

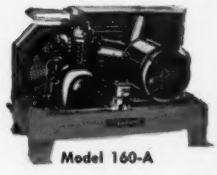
Usually a permanent part of a holdover truck refrigeration system, units are plugged in at the garage and refrigeration stored for the run.

COPELAMETIC
½ H.P. THROUGH 3 H.P.
(3 H.P. M. & L. TEMP.)

Write for technical bulletins on Copeland products that fit your needs.



BELT-DRIVEN



Model 160-A

REMOTE, AIR-COOLED
¼ H.P. THROUGH 3 H.P.
SELF-CONTAINED
AIR-COOLED
1/6 H.P. THROUGH ½ H.P.
REMOTE, WATER-COOLED
½ H.P. THROUGH 7½ H.P.
COMBINATION
AIR-WATER COOLED
½ H.P. THROUGH 3 H.P.
TRUCK MODELS
½ H.P. THROUGH 3 H.P.

SALES FOLLOW-THROUGH

From an application for guided missiles to a single-room air conditioner, Copeland and Copeland wholesalers offer the technical assistance that keeps customers satisfied. Let us review your application requirements.

SINCE 1918 Copeland REFRIGERATION CORPORATION, Sidney, Ohio

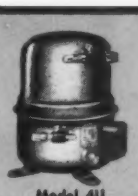
YOUR COMPLETE SOURCE FOR '61

From freezing foods to cooling homes...

Copeland COMPRESSORS

COPELAWELD
COPELAMETIC
BELT-DRIVEN

WELDED HERMETICS



Model 4U



Model 2U



Model CF 18S SPACE SAVER

DESCRIPTION	**COPELAWELD** WELDED HERMETIC MOTOR-COMPRESSORS 4 CYLS. 1750 R.P.M.	**COPELAWELD** WELDED HERMETIC MOTOR-COMPRESSORS 2 CYLS. 1750 R.P.M.	**COPELAWELD** WELDED HERMETIC MOTOR-COMPRESSORS • WING BASE MODELS • FLAT BASE MODELS
HORSEPOWER RANGE	**2½ H.P. THROUGH 5 H.P.** SINGLE AND THREE PHASE	**½ H.P. THROUGH 2 H.P.** SINGLE PHASE MODELS	**1/12 H.P. THROUGH ⅓ H.P** 115/1/60
APPLICATION	UNITARY AIR CONDITIONERS AND HEAT PUMPS	ROOM AIR CONDITIONERS • UNITARY AIR CONDITIONERS	REFRIGERATORS FREEZERS WATER COOLERS VENDING MACHINES BEVERAGE COOLERS AND MANY OTHER APPLICATIONS

Copeland CONDENSING UNITS

FOR ALL HIGH, MEDIUM AND LOW TEMPERATURE APPLICATIONS

SPACE SAVERS



Model EKD-331

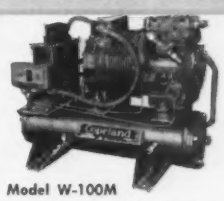
COPELAWELD
HIGH, MEDIUM AND LOW TEMPERATURE UNITS
⅛ H.P. THROUGH ½ H.P.

REMOTE AIR-COOLED

These NEW MODELS will be introduced at the 15th INTERNATIONAL HEATING and AIR CONDITIONING EXPOSITION CHICAGO • FEB. 13-16

½ H.P. THROUGH 7½ H.P.

REMOTE WATER-COOLED



Model W-100M

COPELAMETIC
½ H.P. THROUGH 10 H.P.

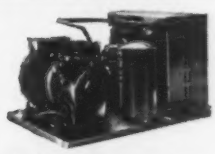
REMOTE CONDENSER UNITS



Model N-300L

COPELAMETIC
½ H.P. THROUGH 10 H.P.

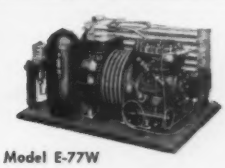
SELF-CONTAINED AIR-COOLED



Model E-75

COPELAMETIC
¼ H.P. THROUGH 1 H.P.

SELF-CONTAINED WATER-COOLED



Model E-77W

COPELAMETIC
⅓ H.P. THROUGH ¾ H.P.

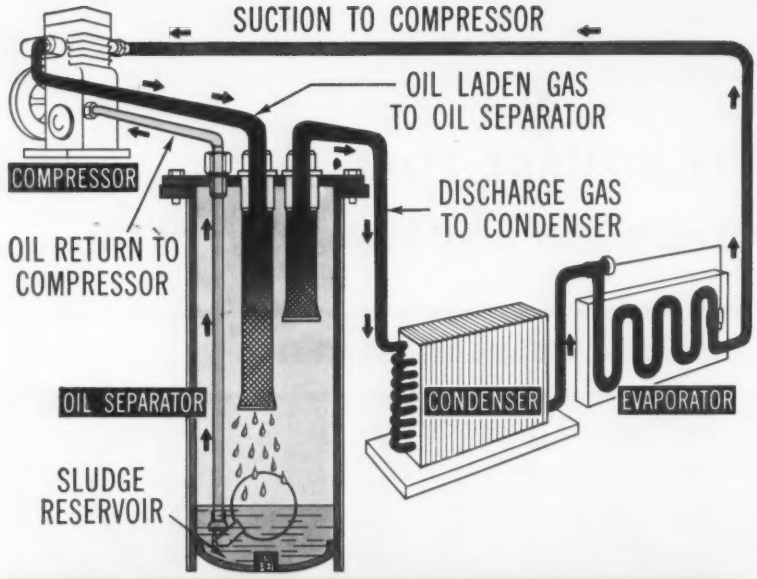
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valves, electrical controls and sump pumps are described in 12-page Catalog 6600. Because of the simplicity of the system, the same equipment used in residential installations can also be applied to larger buildings, such as stores, offices, schools and factories.

Included in the bulletin are product illustrations, cut-away views, capacity charts and extensive specifications.

Triplex Heating Specialty Company, Inc., Peru, Ind.

Roof Exhaust Fans. Two four-page bulletins, PC-101 and SS-101, are descriptive of "Pleasing Contour" and low velocity, high capacity SS roof exhaust fans. Contained are dimension table, product diagrams, capacity table, cutaway view, typical specifications and installation photographs.

Davidson Fan Company, 213 California St., Newton 58, Mass.

Refrigeration Catalog. Photographs and extensive descriptions, together with concise tables, present this line of commercial refrigeration equipment. Detailed information on specifications, capacities and accessories is included in a 16-page catalog, with series of rapid selection tables given for walk-in coolers, freezers and hardening rooms.

McQuay, Inc., 1600 Broadway St. N.E., Minenapolis 13, Minn.

Air Control Valves. Presenting a new, tested design of mechanically and manually operated air control valves, Bulletin 60-1 covers ¼-in. NPT, two-position balanced spool valves in normally closed or normally open two, three and four-way styles.

On a three-page spread are presented all model numbers, specifications and operators in a single chart. Valve operator availabilities catalogued include knob, lever, clevis, roller cam, over-riding roller cams, foot pedal, treadle and air models. Standard accessories, such as mounting foot, detent section, return spring and sub-base mounting, are listed.

Hoffman Valves, Inc., 2360 W. Dorothy Lane, Dayton 39, Ohio.

Instrument Application Manual. Maintenance and inspection practices to foretell and prevent failure for many different types of electrical industrial equipment are described in 52-page Manual D-62. Amply illustrated with graphs, tables and pictures, the manual highlights methods and instruments for voltage breakdown tests and measurement of insulation leakage at

high voltage. Procedures for predicting life of motor and generator insulation, testing for breakdown of cable installations and rebuilt motors and generators are described. Precise performance data, as well as case histories of actual applications in industry, are included.

Among test equipment and applications covered are: Vibrotest for insulation resistance, Vibroground for ground resistance and earth resistivity and Hypot for ac and dc high voltage breakdown. Maintenance testing covers motors, generators, cables, switchgear, transformers, capacitors and electrical heating devices.

Associated Research, Inc., 3777 W. Belmont Ave., Chicago 18, Ill.

Home Air Filters. Air from the home is drawn into the return air ducts by a fan in the heating or cooling unit and passed through the Electro-Klean, which acts electronically to strain dirt particles from the air. Installation of the unit is illustrated and explained and capacities of various models in the line are tabulated in eight-page Bulletin 256-E4.

American Air Filter Company, Inc., 215 Central Ave., Louisville 8, Ky.

Metals Joining. Brazing was used to solve specific problems in various metals joining applications detailed in four-page Brazing News #84. A variety of parts, components and products are discussed, involving both similar and dissimilar metals.

Handy & Harman, 82 Fulton St., New York 38, N. Y.

Unit Heaters. Free standing, wall-mounted, semi-recessed, fully recessed and ceiling-mounted electric console unit heaters are covered in eight-page Bulletin F21100. Designed for use in lobbies, corridors, waiting rooms, offices, stores, churches, schools and many other applications, units provide extensive flexibility, with a variety of inlet and discharge air arrangements.

Descriptions are detailed and supplemented with product illustrations. Also included are data on performance, selection, application, dimensions, operation and nomenclature.

Edwin L. Weigand Company, 7500 Thomas Blvd., Pittsburgh 8, Pa.

Water Treatment. Suitable for treating recirculating cooling water and process water systems with deposit problems, #82 is a blend of polyphosphate and organic chemicals which may be used alone, in conjunction with acid, or supplemented by some other formula for all-around pro-

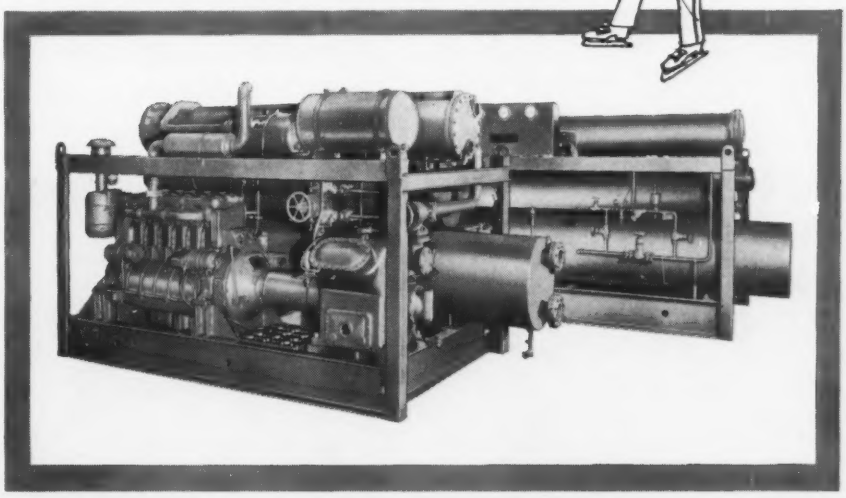
(*Continued on page* 139)

Holiday on Ice skates through Africa on Vilter Ice



SEE US AT BOOTH 329

Holiday on Ice shows, using portable Vilter refrigeration units for building ice surfaces, have been presented in Europe, Middle East, India, Far East, South Africa since 1952.



View showing the two Vilter Ammonia Brine Uni-Chillers shipped in 1960 to Mombasa, Kenya, for Holiday on Ice, Inc.'s latest African tour under State Department sponsorship. The itinerary for the African Show will include Mombasa; Entebbe, Uganda; Dar es Salaam, Tanganyika; and Nairobi.

Last April in Khartoum, Sudan, in 120° temperature, Vilter provided refrigeration for the ice surface of another successful Holiday on Ice Show under State Department auspices.

Since 1952, Holiday on Ice Shows, Inc.'s foreign show units have been using a portable Vilter refrigeration unit for building ice surfaces. In the fall of 1959, this Vilter unit was returned to the United States for rebuilding. According to Mr. A. R. Grant, Business Manager, Holiday on Ice, "We were very much impressed at that time to find that the Vilter equipment required very little work to put it back in top operating condition. It was this experience which led us to select Vilter equipment again for the new 1960 African tour, where we expect to encounter rather extreme conditions."

Two new Vilter refrigeration units were shipped in 1960 to Mombasa, Kenya.

Each Vilter unit consists of a self-contained, fully automatic Ammonia Brine Uni-Chiller, including a 4-cylinder VMC compressor, 16″ x 10′ condenser, a 20″ x 12′ chiller, and a Diesel engine.

Each unit is capable of producing 30 tons of refrigeration and together will develop an ice surface of approximately 60′ x 100′ under any condition.

Vilter equipment has again proven itself as it has in thousands of other installations. Quality design and workmanship pay off in long years of reliable operation—good value for your investment dollar.

Why not see Vilter about your refrigeration or air conditioning application?

Complete ice rink installation engineered by Peter Carver Associates, New York.



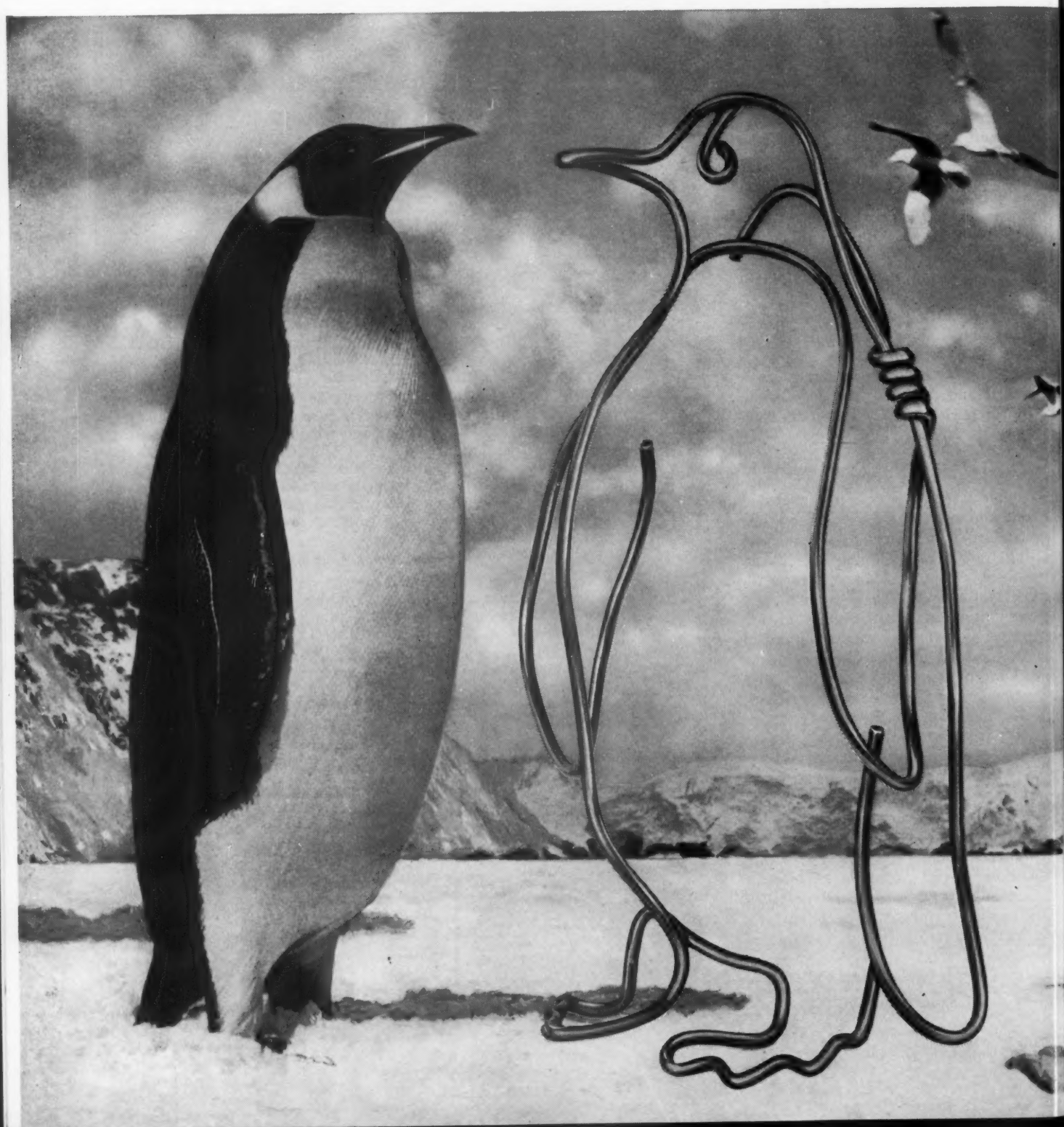
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The Vilter Manufacturing Company
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Write for Bulletins on above equipment to The Vilter Manufacturing Company, Dept. AR-600 2217 South First Street Milwaukee 7, Wisconsin

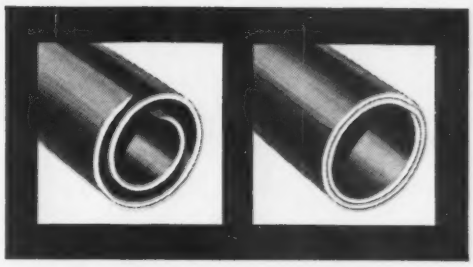
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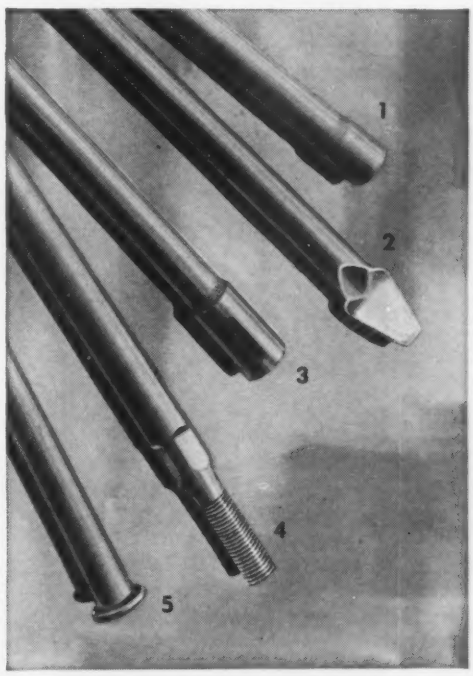
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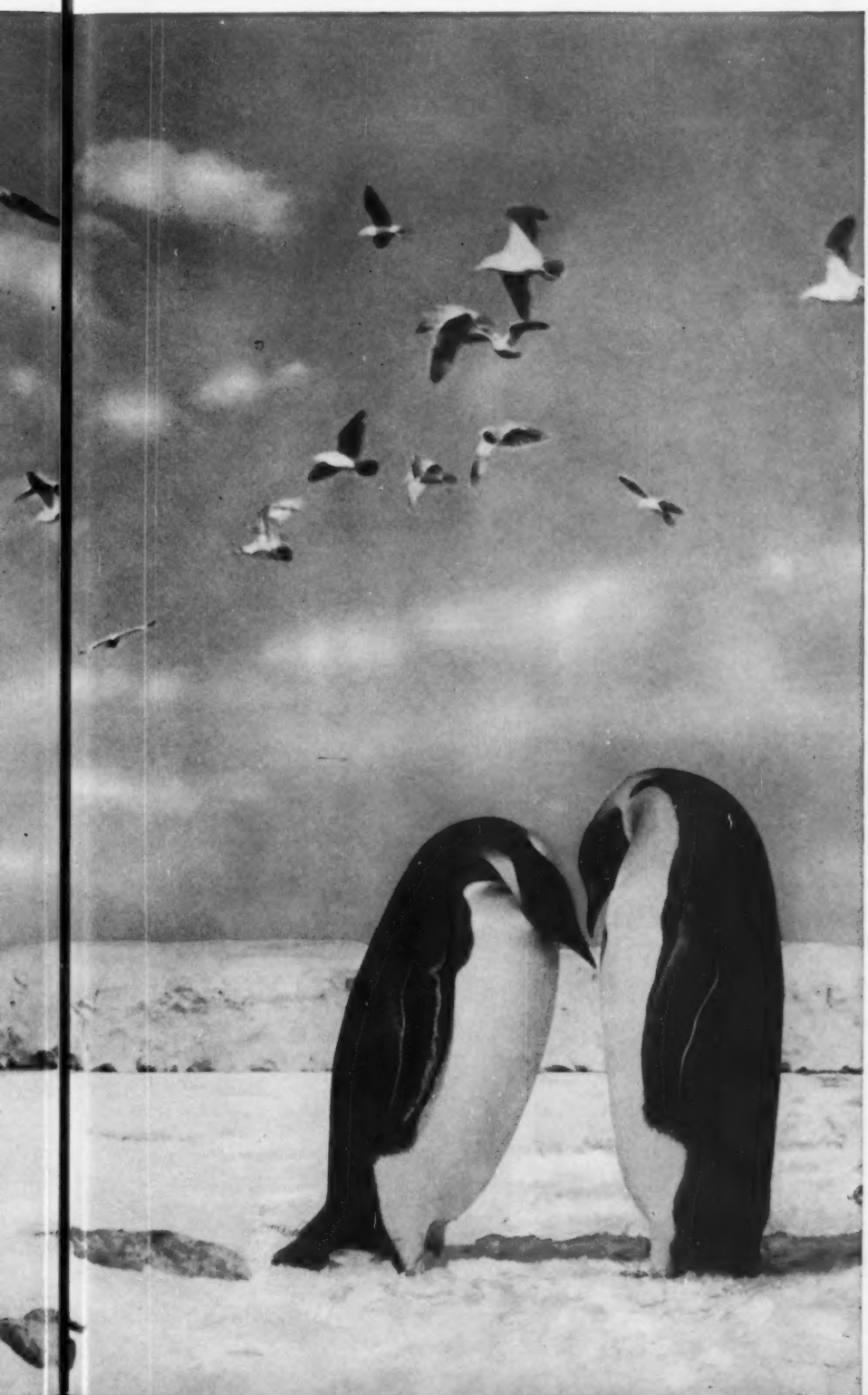
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Bundy can mass-fabricate small-diameter steel tubing to solve a wide variety of design problems. The Bundyweld tubing shown is (1) expanded, (2) sheared and flattened, (3) expanded and slotted, (4) special formed and threaded, and (5) flanged.



BUNDYWELD® TUBING

PRESSURE LOSS

(*Continued from page* 85)

the values given by Moody, for similar degrees of relative roughness. For the relatively smooth plywood there is little difference between experimental and cited values of friction factor. In the laminar range the results were similar to those of Figs. 3 and 4, except for wood fiberboard. A repetition of the test with the wood fiberboard duct at a later date substantiated the original measurements.

A numerical comparison of experimental and cited results for the four materials tested, at three representative values of N_R, is given in Table I. Nikuradse's results do not extend to a sufficiently high degree of relative roughness to allow an estimate to be made for corkboard.

CONCLUSION

The results presented in this report should facilitate prediction of air friction pressure loss in shallow rectangular ducts under conditions likely to be of interest in the design of refrigerated storages and transport vehicles. They indicate that but small error results from using the hydraulic diameter parameter in correlating results obtained with turbulent flow in ducts of various shapes and sizes. Also indicated is that in the laminar range an equation derived for rectangular ducts should be used in preference to the relation $f = \frac{64}{N_R}$, which is correct for cylindrical ducts. Finally, the difference between the results obtained for three of the four materials tested and the widely used chart drawn by Moody indicates that caution should be used in predicting friction factors for materials not tested previously, and emphasizes the need for further study of the relation between roughness and friction pressure loss.



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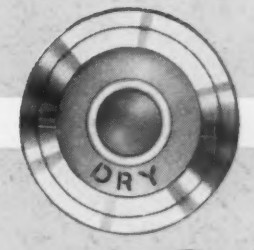
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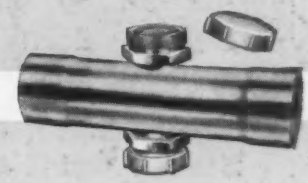
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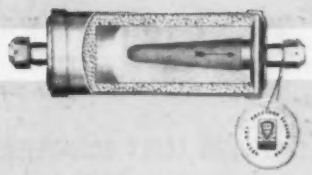
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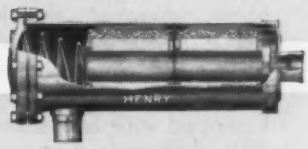
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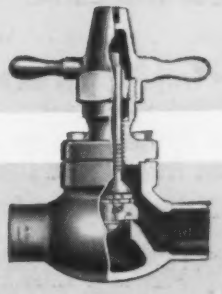
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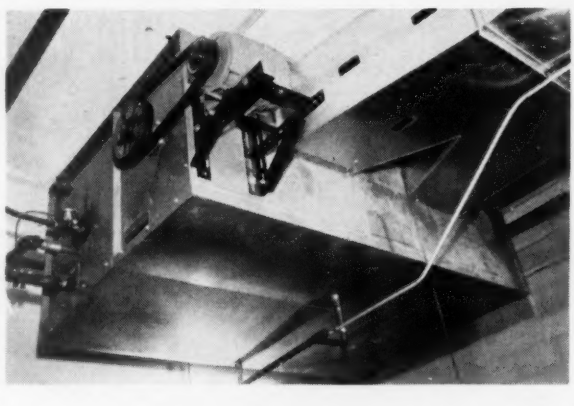
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Applications

AIR CONDITIONING CONTROLS BANANA RIPENING

Using Dunham-Bush air conditioning equipment to service 28 rooms with temperature and humidity control, Levin Banana Storage and Food Distribution Center, Philadelphia, Pa., controls banana ripening to prescribed time intervals. Average ripening time for bananas is 80 hr.

Eight of the rooms are serviced with ten-hp Brunner compressors using twenty-ton air-cooled blower condensers. Heat-X pressure stabilizers are utilized to maintain operating head pressures during the winter months. Water-cooled ten-hp condensing



units and a fifty-ton cooling tower comprise the rest of the system for the other rooms. Additionally, horizontal air handling units are used for cooling the rooms and providing proper air distribution. Shown is a close-up of the ceiling-mounted cooling system.

FOUR MAKE-UP UNITS REPLENISH PROCESSING PLANT AIR

Recently installed by Graniteville Company, Graniteville, S. C., four packaged air make-up units will replace air exhausted to the atmosphere by bleachery processing equipment. Some 1,000,000 cfm are exhausted by dry cans and mercerizing, wash and resin curing ranges, and are discharged to the atmosphere by more than 35 exhaust hoods. Of this quantity of air, but 60% is replaced by heating and ventilating systems and by the circulation system designed to prevent condensation on the ceiling. Without an additional air supply, this loss of air would produce a negative pressure and cause drafts at doorways and windows.

Manufactured by J. O. Ross Engineering Div of the Midland-Ross Corporation, the make-up units supply 60,000 cfm each, bringing the total replacement air to 80% of that exhausted. Each unit con-

COMPLETE

C-O-M-P-L-E-T-E–that's the word that best describes Wolverine Tube's finned tube product line and customer services.

For example, illustrated here are seven different types of Wolverine Trufin®–the integrally finned tube. Included are both low-finned and high-finned types for such applications as shell and tube units, water heaters and boilers and air cooled heat transfer requirements.

Wolverine Tube has manufactured integrally finned tube much longer than any other company in the industry; thus, Wolverine customers have a reliable and readily available source for finned tube literature, information and technical heat transfer consultation and guidance.

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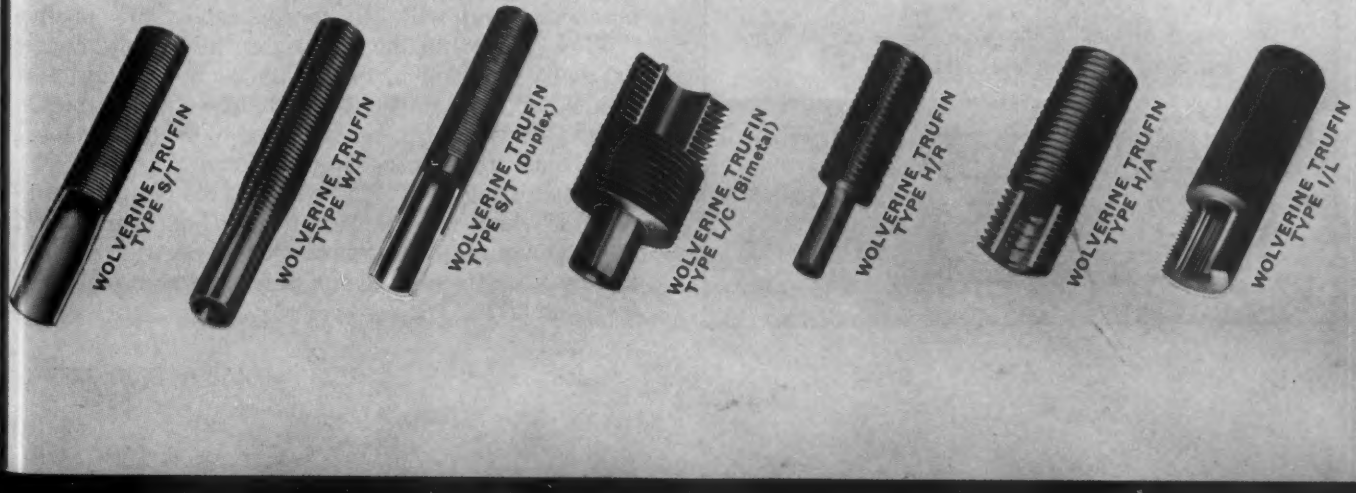


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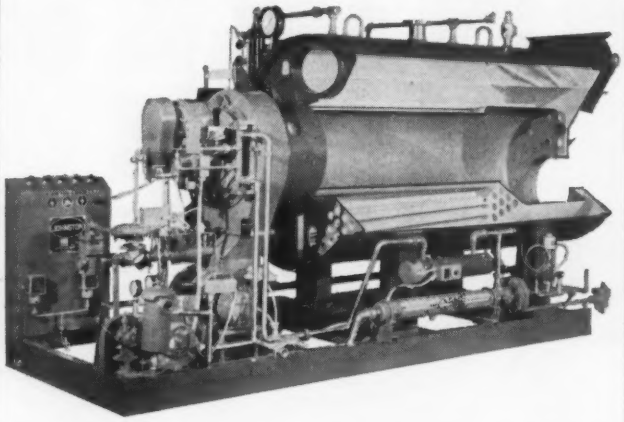
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sists of a galvanized enclosure equipped with two access doors. Fitted onto the end which inserts into an outside wall opening are louvers, bird screens and shut-down dampers. The other end is equipped with an axial fan which draws air from outside and directs it into the plant. Internal burners heat incoming air in winter and three-in. rock wool insulation prevents wintertime condensation.

SUSPENDED CEILING UTILIZED AS AIR DIFFUSER

Intended mainly as an experiment to test the efficiency of perforated mineral tile ceilings as air diffusers, the system developed for the general office building of Armstrong Cork Company in Lancaster, Pa., proved successful. Besides providing acoustical treatment and improved air circulation, it was economical to install, through elimination of standard diffusers and a considerable amount of duct work. Duct stubs were all that was required in each room to discharge the conditioned air into the plenum space above the suspended ceiling.

Presently in use are two different incombustible mineral acoustical materials, Full Random Minatone and Fissured Travertone, both manufactured by Armstrong. Small air diffuser holes drilled through these materials have little effect on their acoustical properties. Air is recirculated with 25% new air added. Individual room thermostats regulate booster heater coils in the stub ducts to provide separate room temperature control. Air leaves the central cooling system at 58 F and is warmed to the desired temperature by the booster heater before it passes down through the ceiling.

FUTURE EXPANSION PROVIDED IN CENTRAL PLANT

Now under construction at Trinity University in San Antonio, Texas, a central heating and cooling plant will pipe hot and chilled water to several campus buildings for year-round air conditioning. University officials decided on a central plant because it offers lower initial costs than individual room or building units and provides greater flexibility in meeting changing loads.

George Storch Memorial Library and Preston Northrup Hall, a classroom and administrative building, will be the first structures to be served by the new plant and will use approximately 50% of the 375-ton capacity of the initial absorption unit. Space has been provided in the utility center for addition of another heat-activated unit to serve future buildings. The system can be expanded to eventually total more than 1000 ton cooling capacity.

Energizing the system will be a single fuel, natural gas, which will be used by the boiler to supply high temperature hot water utilized by the absorption machine for cooling and by a hot water generator for heating.

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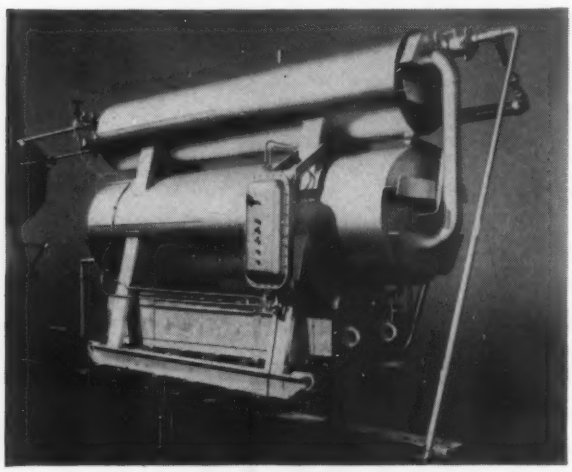
8328

The one complete line of refrigerant controls: Thermostatic Expansion Valves • Refrigerant Distributors • Solenoid Valves Refrigerant Filter-Driers • Suction Line Regulators • Flooded Evaporator Controls and Reversing Valves

PARTS AND PRODUCTS

GAS ABSORPTION COOLER

Developed for use as an air conditioning unit for large structures such as office buildings, hotels, theaters and auditoriums, as well as for many processing plant cooling applications, this gas absorption cooler



can be used also for home air conditioning. The model shown has a refrigeration capacity of 150 ton.

In application of the two-effect generator principle of operation, heat is applied to a spent solution of lithium bromide in the first-effect generator. This solution boils, liberating water vapor, and produces a more concentrated solution, which then passes through a coil serving as a second-effect generator. Pressure here is lower than in the first generator and, because of this reduced pressure, the solution boils at a lower temperature. Thus, the second coil is heated by the condensing vapor from the first distillation step, saving the additional fuel which otherwise would be required. Vapor from the second-effect generator is condensed on a water-cooled condenser coil.

Combined condensate from both the first and second-effect generators is delivered to the evaporator. The resultant refrigerant is pumped over the chiller coil, where it cools the coil by evaporation. Vapor from this process is absorbed by the concentrated lithium bromide solution which, in its dilute state, is pumped to the first-effect generator and the cycle is repeated.

Statham Instruments, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.

MOLDED RUBBER BOOT

Use of tubular heaters for refrigeration defrosting and other applications requiring moisture protection is made possible by development of a molded rubber boot. Designed for operation from —40 to 185 F by protecting heater terminal connections from frost or moisture accumulation, the rubber boot is free of

GET ACCURATE FLOODED SYSTEMS CONTROL

with this level regulator

A SIMPLE CONTROL IS THE BEST CONTROL

PHILLIPS
FLOAT CONTROLS



- **Proportioning action for smooth feed at all capacities**
- **Tight Closing with Teflon seat discs**
- **Self actuation—no electrical or pneumatic connections needed**
- **Visible liquid level through exclusive "Level Eyes"**
- **Adjustable level achieves maximum capacity with minimum charge**

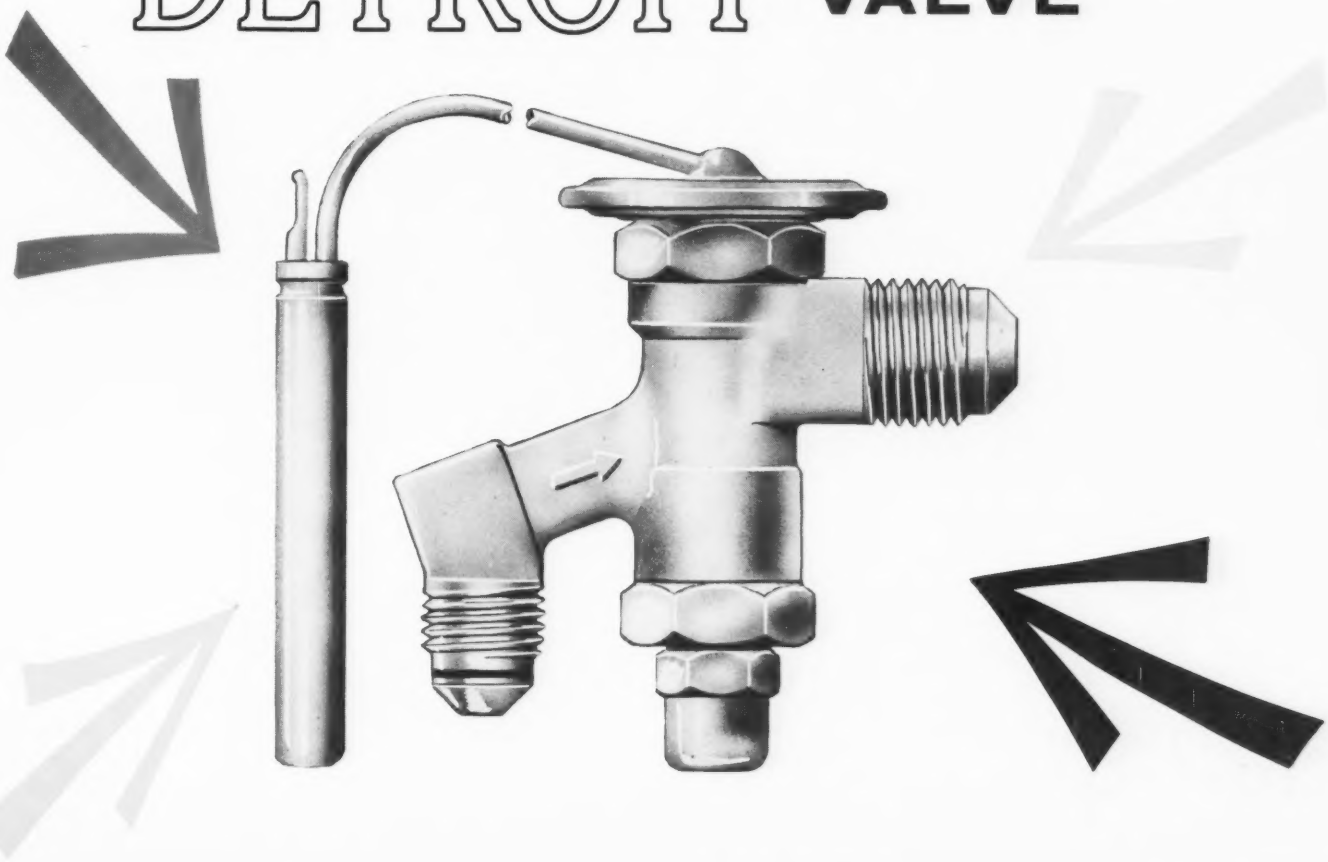
IN ADDITION — Phillips pilot operated valves are available for all common refrigerants, down to —50° F. Operates with as low as 2 PSI pressure drop and up to 250 PSI with selected springs. Line sizes ½ inch to 4 inches with steel or copper connections.

Solve your flooded system design and application jobs by consulting Phillips. Our firm of engineers have specialized in level control, liquid-vapor separation, liquid circulation and return systems for over 28 years.

H. A. PHILLIPS & CO.
Designers and Engineers
Refrigeration Control Systems
3255 W. Carroll Ave.
Chicago 24, Illinois

introducing

A BRAND NEW DETROIT VALVE



COMPLETELY INTERCHANGEABLE—SAVES SPACE, TOO!

Compact in size but with the capacity to do a big job! That's the description of the new Detroit 900 expansion valve. It is ideally suited for general replacement installations where space is at a premium. Inlet and outlet connections are in the same position as bulkier valves, allowing easy replacement without repiping.

There are only three moving parts! The valve is easily disassembled for inspection and cleaning without removal from the refrigerant line.

Also available externally equalized. Tons capacity: R-12 – .5 to 3; R-22 – .8 to 5.

LOADED WITH PLUS VALUE FEATURES

POWER ELEMENT – The small removable stainless steel power element is shielded-arc welded by specially developed equipment. In this design and method of assembly, full diaphragm flexibility is accomplished. The COMPACT CAPACITY line features long life and trouble-free operation. Available in Detroit custom "C" or "Z" charges. Also available with a built-in pressure limiting element to guard against motor overloading and burnout if required.

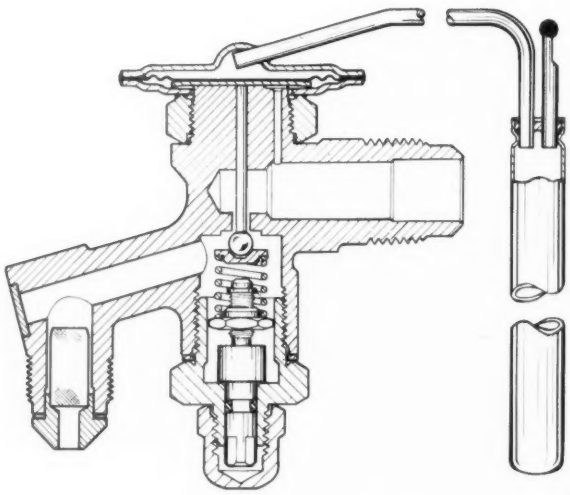
BODY – A high density brass forging. Inlet location, and minimum number of parts, allows full and free flow of refrigerant through the valve. This simplicity of construction provides high capacity for the small size.

LARGE INLET STRAINER – Easily removed for cleaning–held in position by a retainer clip.

BALL NEEDLE AND PUSH ROD – Self aligning and self centering–seats perfectly every time. Ball is concentric to push rod.

ONLY THREE MOVING PARTS–Smoother operation and longer life. No clips, extra springs or miscellaneous parts.

EASY TO SERVICE–Valve easily disassembled for inspection and cleaning.



announcing

A NEW NAME FOR AN OLD-LINE COMPANY

Detroit expansion valves are a well-known product of an old-line company. American Standard Controls Division is the new name for that company–selected because it better describes the newer and broader operations. We are bigger not only in refrigeration and air conditioning, but in many, many other industries as well. Write today for information about products which control or indicate the pressure or temperature of gases, fluids or electrical energy.

AMERICAN-STANDARD CONTROLS DIVISION
5900 TRUMBULL, DETROIT 8, MICHIGAN

AMERICAN-Standard
CONTROLS DIVISION

THERE ARE LOTS OF REFRIGERATION DRIERS that control moisture, remove acid and filter solids . . . none of them do these things better than the ANSUL T-FLO DRIER. And . . . there's only one drier, the ANSUL T-FLO that can be replaced as quickly and easily as changing a light bulb . . . that offers the unique possibilities for manifolding . . . that can be connected directly to a moisture indicator without breaking the line. The ANSUL T-FLO DRIER was developed by refrigeration people with imagination . . . for refrigeration people with problems. They're available from refrigeration wholesalers everywhere. **ANSUL**

ansul t·flo drier



ANSUL CHEMICAL COMPANY
MARINETTE, WISCONSIN
Exclusive sales agents
for UCON brand refrigerants,
manufacturers of
refrigeration products,
fire extinguishing equipment
and industrial chemicals.



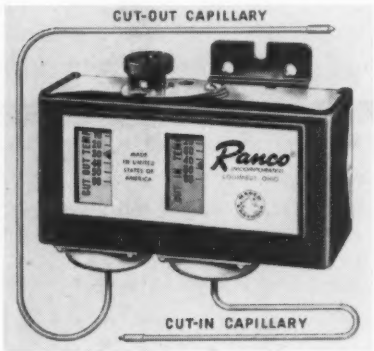
SEE US AT BOOTH 966

taste or odor and is oil resistant. Boot is 1¾ in. long and 7/16 in. diam.

Tubular heaters with 0.260 and 0.315-in. diam of steel, stainless steel, Incoloy, Inconel and aluminum sheaths can be supplied with the new boot. Special diameters are available on request.
General Electric Company, Schenectady 5, N. Y.

TWO-TEMPERATURE UNIT

Designed especially for use on commercial fixtures such as walk-in coolers, display cases and florist boxes, the



019 control effects frequent cycling of the refrigeration system to maintain uniform air temperature and high relative humidity. Compressor is started when the evaporator is defrosted after each running cycle and stopped when fixture air temperature is reached. Each action is independent at a predetermined setting.

Duration of refrigeration from cut-in to cut-out settings is variable for each running cycle according to internal load and weather conditions. Fixture air temperature is adjustable with a knob from one to ten positions without affecting evaporator defrost. **Ranco Inc., 601 W. Fifth Ave., Columbus 1, Ohio.**

CONNECTOR

Incorporated in the Quick-Seal Connecto-Valve is a long, hollow shaft which enables workers to make fast, leak-tight connections of gas lines to burners installed in appliances. A cam handle actuates the expanding seal, which can seal threaded or smooth openings. At the time the seal expands, an internal valve is opened, permitting gas to flow through the shaft and into the burner. Returning the handle to its original position shuts the valve, stopping the gas flow,



and contracts the seal, permitting it to be withdrawn from the opening. **Mechanical Products Corporation, 1716 W. Hubbard St., Chicago 22, Illinois.**

COMPRESSORS

Developed for aircraft, missile and air transportation use, this line of lightweight, high efficiency refrigeration compressors features a system of cooling that permits the entire unit to be sealed hermetically. Unlike conventional air-cooled compressors, these units are cooled by circulating compressed refrigerant gas through the coaxially-mounted motor and compressor elements. A further design refinement makes use of a first stage precooling circuit to maintain



BUY SPORLAN *Catch-Alls*

. . . the Perfect Filter-Drier for every capacity
from fractional horse-power units to large capacity installations



Sporlan offers a complete range of Catch-Alls engineered to fit every application, from domestic refrigerators, small freezers and vending machines to the largest commercial and industrial refrigeration and air conditioning systems, with every conceivable job size in between.

No matter how large or small the job you are planning, your filter-drier worries stop when you buy Sporlan Catch-Alls.

In addition, the Sporlan Catch-All is the perfect filter-drier because . . .

- Desiccants are molded into a porous core.
- Maximum drying through highest degree of activation.
- Filtering instead of straining.
- Superior acid removal.
- Refrigerant cannot channel through or by-pass around the core.
- Core will not powder or pack.
- Full line flow protection for any size system.
- Connections are protected by moisture and tamper-proof seals.

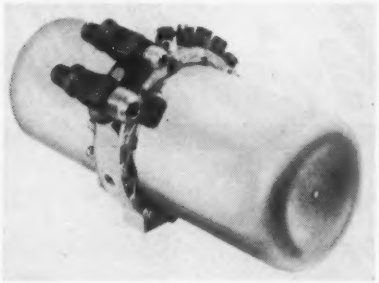
See your Sporlan Wholesaler for your Catch-All needs today and ask him for a copy of Bulletin 40-10.

See you at
Booth No. 1254
15th INTERNATIONAL
HEATING & AIR CONDITIONING EXPOSITION
Chicago, Illinois February 13-16, 1961

SPORLAN VALVE COMPANY
7525 SUSSEX AVENUE ST. LOUIS 17, MISSOURI

EXPORT DEPT. • 85 BROAD STREET • NEW YORK 4, N. Y.

halogenated hydrocarbon refrigerant within its stable operating range of 250 F. Also featured is a centrifugal



separator which removes refrigerant-entrained lubricating oil before it has a chance to pass through the refrigeration condenser.

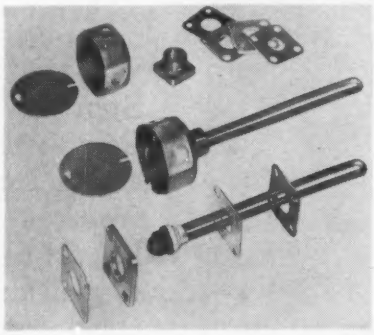
Units are available in six models, ranging from ¼ to 4 hp. Operating at comparatively low speeds (3600 rpm), they offer long, maintenance-free operating life and reliability.

Task Corporation, 1009 E. Vermont Ave., Anaheim, Calif.

HEATING ELEMENT

Available in outputs of up to 7000 watt, single-phase, this corrosion-resistant, copper sheathed element for domestic or commercial hot water tanks was designed to lessen maintenance costs by providing a heating density of 150 watt/sq in. This high density is cited as removing heavy lime deposits at the start of each heating cycle, and permits use of shorter elements. Element is supplied with a non-hardening, non-sticking silicone rubber seal which also provides electrical insulation between tank and element.

Model 139 is factory-equipped with a built-in Varistor, which automatically minimizes the amount of cathodic current used to protect the heater sheath against corrosion, cited as pro-

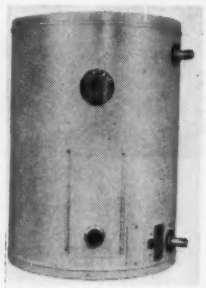


longing the life of glass-lined tanks.

Thermo-Craft Electric Corporation, 429 E. 164th St., New York 56, N. Y.

WATER HEATERS

Available in both round and square styles and 3, 6, 12 and 18-gal sizes, Bantam water heaters combine anticorrosive glass-lined tanks and anode magnesium rods for double protection. Exterior surface of the tank is smoothed to afford precision fitting of Heat-Belt elements, minimizing chance of element failure and assuring maximum output. Shown is the 18-gal round model.



Teter, Inc., 13901 S. Indiana Ave., Chicago 27, Ill.

EXPANSION TANK

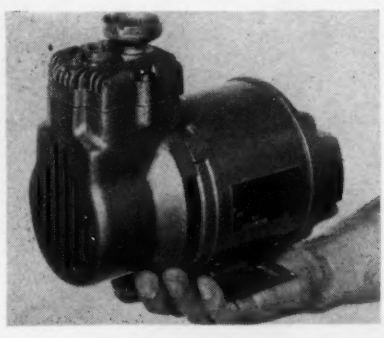
For hot water heating systems, the Flexamatic tank is cited as overcoming air problems and water-logged conditions through factory-charged and sealed construction.



Flair Manufacturing Corp., 1720 Atlantic Ave., Brooklyn 13, N. Y.

COMPRESSOR, PUMP

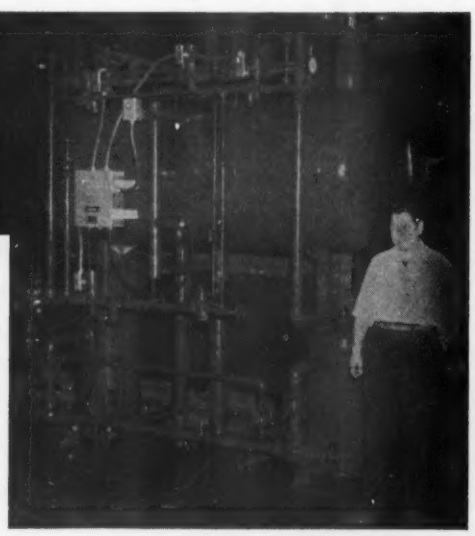
Now available is a miniature 1/12-hp oilless motor-powered compressor and vacuum pump that delivers more free air than rotary, diaphragm or piston-design units. Because of its



small size and quiet operation, the unit is suited for a wide range of industrial, laboratory and office uses.

Two models are available: Model LV, which has a 1.9 cfm displacement and is capable of continuous operation up to 27 in. vacuum, and LC, with a displacement of 1.43 cfm and capable of continuous operation to a pressure of 65 psig. Both models

THE ULTIMATE IN THE COMPRESSION REFRIGERATION CYCLE*



THIS IS ANOTHER CYCLE CENTER, factory assembled and on its way to a 150 ton poultry freezing plant.

What will it do?*

It will provide liquid overfeed to the evaporators, catch the excess liquid and recirculate it to the evaporators, with these results:

- FULL COMPRESSOR PROTECTION AGAINST SLUGS
- PEAK COIL AND COMPRESSOR EFFICIENCIES
- SUB COOLED LIQUID FEED AT CONSTANT PRESSURE THE YEAR AROUND
- PRACTICALLY UNLIMITED RATE OF LIQUID FEED AT ABSOLUTELY NO POWER COST
- NO MECHANICAL PUMPS
- NO FLASH GAS IN LIQUID LINES
- SAFE, AUTOMATIC PLANT OPERATION
- OIL SEPARATION, ANY REFRIGERANT
- HIGHER SUCTION PRESSURES
- LARGE POWER SAVINGS
- LARGE SAVINGS IN FIRST COST ON NEW PLANTS. FOR EXAMPLE, THE RECEIVER IS NOT REQUIRED AND SURGE DRUMS ARE ELIMINATED.
- AUTOMATIC HOT GAS DEFROSTING AT MINIMUM COST

ASK FOR BULLETIN CC-2

*** NOT JUST A LIQUID RETURN UNIT.** Available for any refrigerant, in capacities from 10 to 1,000 tons and more. Factory assembly is optional.

J. E. Watkins Co.
307 LAKE STREET, MAYWOOD, ILLINOIS



For Performance — Capacity — Low Maintenance



Select a

LARKIN ZEPHYRCON

Air-Cooled Condenser

9 Belt-Driven Models—5 to 40 Tons 5 Direct-Drive Models—2 to 10 Tons

ENGINEERED FOR PARALLEL USE FOR VIRTUALLY ANY CAPACITY

Larkin Zephyrcon Air-Cooled Condensers are available in two series: direct-drive FC models—for economy and minimum maintenance; and belt-driven BFC models—for larger installations and the lowest possible noise level.

Multiple circuits—for operating more than one compressor from a single condenser—are available for all models at no extra cost.

PEAK PERFORMANCE YEAR 'ROUND

When used with the Larkin Posi-Trol control system, which maintains head pressures in low ambient temperatures, the Larkin Zephyrcon functions at peak performance the year 'round in any climate.

Compare the features point for point; check the performance data, and make the wise selection—Larkin Zephyrcon Air Cooled Condenser.

SEE US AT BOOTH 326

BASIC RATINGS (30°+D)

FC SERIES — DIRECT DRIVE

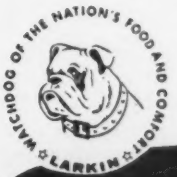
Model No.	*Capacity at Evaporator BTU/HR*	*Tons*	*Cfm*
FC-2	27,700	2.30	2500
FC-3	37,350	3.21	3500
FC-5	62,500	5.21	5500
FC-8	95,600	7.96	7500
FC-10	124,000	10.3	9100

BFC SERIES — BELT DRIVEN

Model No.	*Capacity at Evaporator BTU/HR*	*Tons*	*Cfm*
BFC-5	62,500	5.21	5500
BFC-8	95,600	7.96	7500
BFC-10	124,000	10.3	9100
BFC-13	149,200	12.4	12000
BFC-16	191,200	15.92	15000
BFC-20	248,000	20.6	18200
BFC-26	298,400	24.8	24000
BFC-32	382,400	31.8	30000
BFC-40	496,000	41.2	36400

OUTSTANDING FEATURES

- Patented Larkin cross-fin coil — aluminum fins and staggered copper tubes.
- For use indoors or outdoors.
- A single large fan on BFC model assures low operating noise level.
- Motor on BFC model is standard NEMA design mounted on adjustable base.
- Slow speed motor on FC model is permanently lubricated, has overload protection, and is mounted on resilient base.
- Casing is of heavy-gauge steel.
- Unit finished with baked-on epon-base primer and melamine top coat for maximum protection.
- Motor is enclosed in casing, protected from the weather.
- Discharge shield available.
- Fan Guard is standard equipment.
- Return bends protected by heavy-gauge shield.

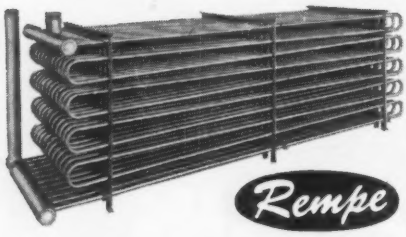


See Your Wholesaler
Or write for Bulletin 1031-C

LARKIN COILS INC.

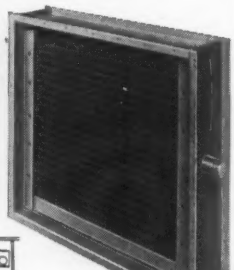
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ATLANTA 1, GEORGIA

REMPE
Heat Transfer Equipment
PIPE COILS
Custom Engineered to Your Requirements



HEAT RECLAIMING UNIT
Typical of the many varieties of coils produced by Rempe from any type of ferrous or non-ferrous pipe and tubing.
Coil illustrated is 15' long with 5" copper headers. Used in floor pit for reclaiming heat from waste process water to preheat boiler feed water. Ideal for reclaiming heat from any hot waste liquid and reducing fuel cost.
Tell us your problem
We'll design the coil

HEAVY DUTY
STEAM COILS
Distributor Type





Tilted feature assures drainage of condensate whether used for vertical or horizontal air flow.

Non-Freeze Design

Every square foot of face area produces equal heating capacity on full or modulated steam supply. Suitable for pressures to 200 lb. gauge.

Two row or one row available. Can be furnished with connections as shown or on opposite end of coil.

Write for Details
Rempe



Engineering Data Book
Pipe Coil and Fin Coil Designs, Heat Transfer Coefficients. Get a copy for your library.

REMPE COMPANY
362 N. Sacramento Blvd. • Chicago 12, Ill.

include a built-in automatic overload protection mechanism that also prevents motor failure in the event of abnormal electrical conditions.

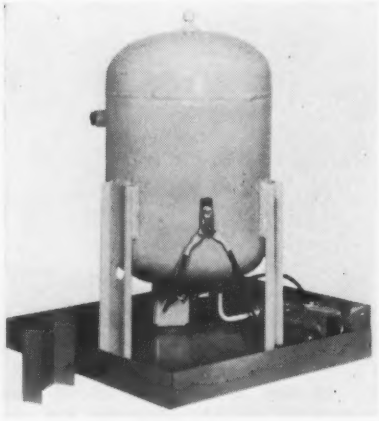
Units operate at 1725 rpm with split-phase, induction-type motors and come complete with carrying handle, 8-ft cord and plug, intake cylinder, ¼-in. IPS discharge connection and four rubber base cushions.
Bell & Gossett Company, Morton Grove, Ill.

WINTER CONTROLS

For air-cooled systems which must operate at low outdoor temperatures, a new line of Winter Condensing Pressure Controls is being introduced. Four sizes of controls suitable for use in systems of five through 15-ton capacity are offered. Multiple units can be installed in larger systems. Advantages include modulation control with no valves or moving parts other than a standard thermostat.

Designated Model 33AA, the new unit consists of a pressure vessel equipped with a thermostatically controlled heater, all enclosed in an insulated casing. The control is teed into the liquid line of the refrigerant circuit and the thermostat is set to maintain the refrigerant inside the vessel at 90 F.

During winter operation, when the saturated condensing temperature drops below 90 F, the thermostatically controlled heater cuts in. Heat vaporizes the refrigerant in the condenser and forces liquid refrigerant out the

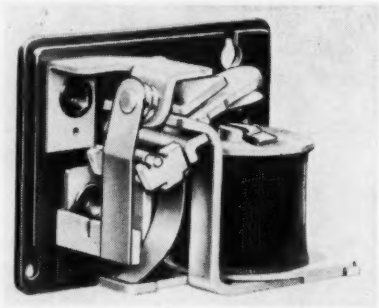


bottom of the vessel and into the refrigerant circuit. Excess refrigerant accumulates in the condenser and reduces the amount of effective condensing surface, causing the condensing pressure and the saturated condensing temperature to rise. This action continues until the condensing temperature reaches 90 F. Above this point, refrigerant will return to the condensing pressure control vessel.

Controls may be installed in any indoor location where the temperature does not go below 50 F. Crankcase heaters should be used on the compressors of systems using this control and receivers must be valved out of the refrigerant circuit during summer operation.
Carrier Corporation, Syracuse 1, N.Y.

RELAY

To provide high starting torque for low temperature systems, commercial refrigeration, air conditioning units and heat pump systems, the H80 voltage starting relay consists of an electro-magnetic switch which opens and closes its contacts by variation of the magnitude of the voltage ap-



plied to the relay coil. At the instant of starting the motor, the normally

HATCHERY

(*Continued from page* 64)

between the thermostat limit settings, about 6½ deg F. Since the troughs contain a relatively large quantity of water, the temperature fluctuation in the troughs only approximates that of the entering water near the point of admission and is reduced to less than one degree at the outlet end. Furthermore, some of the troughs are placed in series with up to three in line. In the second and third troughs of a row the fluctuation is altogether negligible.

ACKNOWLEDGEMENTS

This group of 5th-year mechanical engineering students working on their senior project were: D. Abrams, T. Andrews, E. Burdick, C. Chapman, W. Gundel, B. Howes, H. Paetow, C. Siegel, E. Slater, R. Staley, P. Tregurtha, and G. Valdes. In addition, the author is greatly indebted to James Reckahn, Research Assistant in Fishery Biology, and to C. William Lyon, Fishery Technician, whose continued efforts and enthusiasm in the installation and operation of the equipment contributed greatly to its success.

The Carrier Corporation supplied the water cooling machine described in the text. The efforts of Mr. James Carpenter, Director of Engineering Training, in securing the unit, are much appreciated.

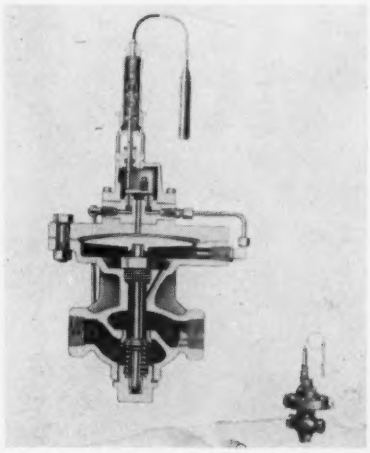
Installation costs were financed from two grants for fishery research made available through Lewis Douglas and Mr. and Mrs. Donald P. Ross.

closed relay contacts stay closed until the motor builds up speed and the start-winding voltage increases. Magnetic force then pulls in the armature to the core, which opens the relay contacts.

Ranco, Inc., 601 W. Fifth Ave., Columbus 1, Ohio.

TEMPERATURE REGULATORS

Designated Eventemp, these new regulators supplement and broaden an existing line of direct acting and Duo-



matic units for storage-type heating and cooling applications. Temperature variations are sensed by a liquid-filled thermal-element which is fully interchangeable when the regulator is on the line. A large variety of thermal-elements, spans and bulb materials is available. Units are supplied with cast iron or bronze bodies, screwed or flanged ends, in an extensive range of sizes from ½ to 4 in. Inlet pressures range to 175 psi, temperatures to 500 F. Optional features include external impulse connections for low inlet pressures, continuous bleed for cooling service and calibrated dials for quick setting.

Leslie Co., Lyndhurst, N. J.

STANDARDS

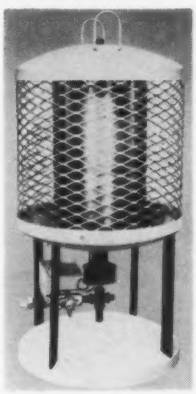
(*Continued from page* 87)

Superintendent of Documents, Government Printing Office, at 10c each. The standard designation is CS230-60, Vinyl Plastic Weatherstrip. This standard establishes three grades of vinyl plastic weatherstrip according to hardness values. Physical properties are given together with test methods for determining the hardness, tensile strength, and other significant characteristics for each grade.

Welding: The American Welding Society has announced availability of a revised AWS Standard Welding Terms and Definitions. This is the first revision in 12 years and a number of changes have been incorporated. In conjunction with the AWS definitions, a new Master Chart of Welding Processes has been prepared. Copies of the AWS Definitions (including Desk Chart) may be obtained for $2 per booklet from AWS, Dept. T, 33 West 39th Street, New York 18, N. Y.

PORTABLE HEATER

Producing large amounts of radiant heat for unheated indoor work areas or as supplemental heat, this portable heater is a high capacity unit which operates on all gases. Products of combustion of the burner are forced out through tiny holes in the stainless steel heat exchanger, causing the entire surface of the exchanger to glow red hot. Radiant energy then is beamed from this surface.



Burner is of heavy cast iron and a wire safety-guard around the heater prevents contact with the perforated screen of the heat exchanger. An added feature is a safety shut-off valve which automatically cuts off gas at the burner if the pilot flame goes out. Rating of the unit is 100,000 Btu/hr.

Space-Ray Corporation, P. O. Box 3485, Charlotte, N. C.

PIPE CUTTER

Designed for use on ten through twenty-in. diam cast iron water main, the Super hydraulic pipe cutter requires no accessory equipment. Unit



is installed readily on a pipe by two men and the pipe can be cut quickly and easily by one man.

Wheeler Manufacturing Corporation, Ashtabula, Ohio.

check these
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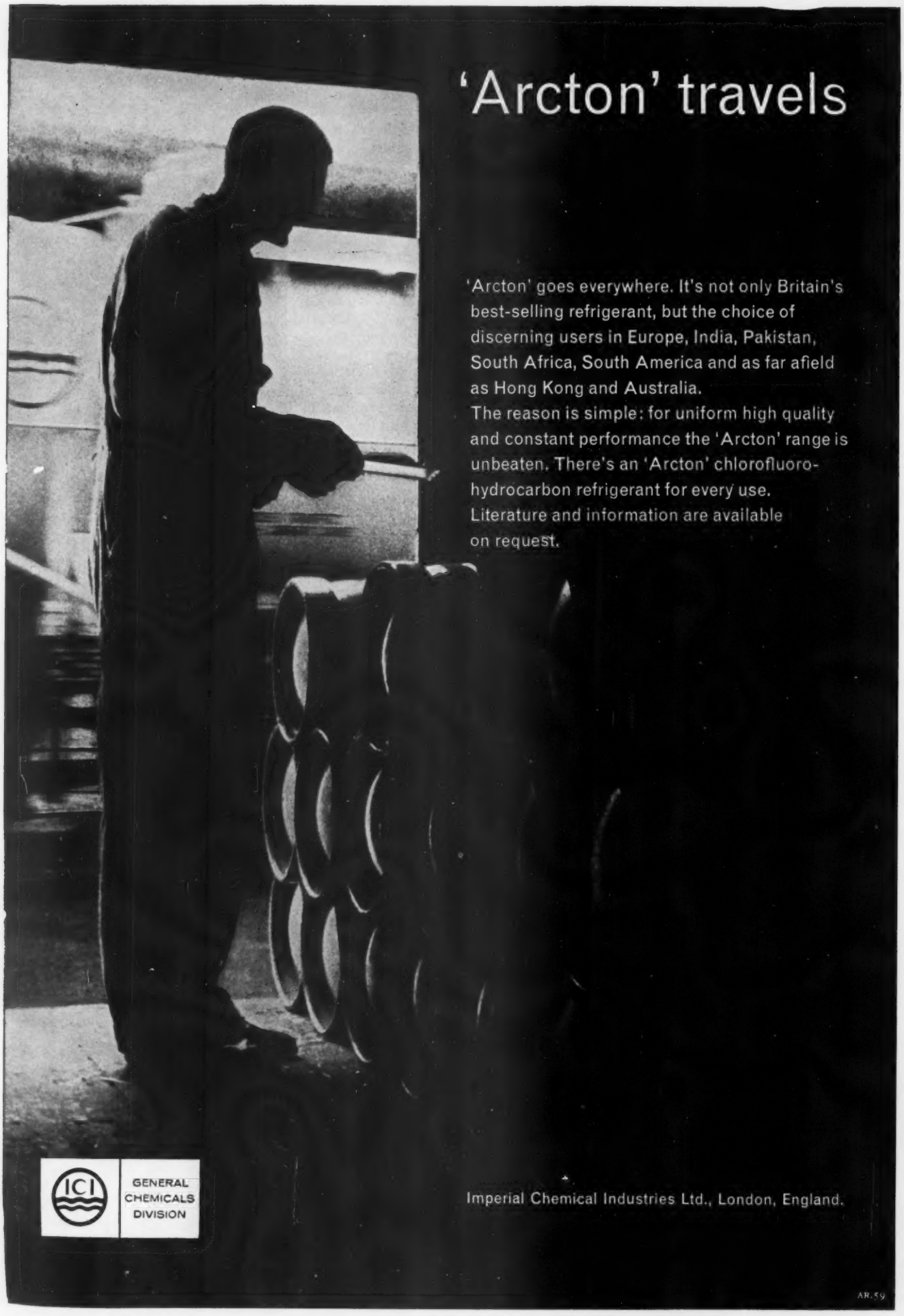
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ICI GENERAL CHEMICALS DIVISION

BULLETINS

(*Continued from page* 119)

tection against scale, corrosion and microbiological growth. Photomicrographs in four-page Process Bulletin C2 show control of crystal growth; other photographs illustrate results obtained in a condenser. Method of application is described.
Nalco Chemical Company, 6216 W. 66th Pl., Chicago 38, Ill.

Gas Unit Heaters. Fan, blower and duct types in 24 models and sizes up to 300,000 Btu/hr are listed in 12-page Bulletin GH-1. Features, specifications, dimensions, standard and optional equipment, blower speeds and hp, controls, construction, duct furnace selection and applications are detailed.
Hastings Air Control, Inc., 3215 Leavenworth St., Omaha 5, Nebr.

Chemical Resistant Pipe. Designated Van-Cor, this pipe is a compound of rigid, unplasticized polyvinyl chloride, available for both normal and high impact, and exhibiting excellent resistance to attack and deterioration by a broad group of industrial chemicals. Lightweight, the pipe has high tensile strength and is cited as being easier to install than conventional pipe. Smooth internal surface has low flow resistance and retards build-up of deposits. Bulletin TWX-CV-829, 32 pages.
Colonial Plastics Manufacturing Company, Industrial Div, 2685 E. 79th St., Cleveland 4, Ohio.

Room Air Conditioners. Adventurer, Conqueror and Discoverer Series air conditioners are the subjects of four-page Bulletins RAC 61-2416, RAC 61-2418 and RAC 61-2417, respectively. Illustrations, features and specifications are included.
York Corporation, subsidiary of Borg-Warner Corporation, York, Pa.

Limit Switches. Describing heavy-duty, metal enclosed, precision snap-acting switches with sealed plunger, roller-plunger, sealed roller-plunger and adjustable roller-lever or hand actuators, four-page Bulletin B-30 includes photographs showing installation methods and structural details. Force and movement specifications are tabulated for all switches.

Covered are Series KL heavy-duty switches, rated one hp at 125 volt ac; two hp at 250 volt ac; 20 amp at 125, 250 and 480 volt ac; and 10-amp tungsten-filament-lamp load at 125 volt ac. Also presented are Series K general purpose switches rated 20 amp at 125, 250 and 480 volt ac; 0.25 amp at 250 volt dc and 0.50 amp at 125 volt dc.
Unimax Switch Div, W. L. Maxson Corporation, Ives Rd., Wallingford, Conn.

Heat Exchangers. Subject headings of 24-page Catalog 601 include: engineering data, convertors, snow melting radiant panels, instantaneous heaters, booster heaters, condensate coolers, below-the-line feedwater heaters, dimensions and pressure drop. Tabular data is extensive and piping diagrams are presented.
Old Dominion Iron & Steel Corporation, Belle Isle, Richmond, Va.

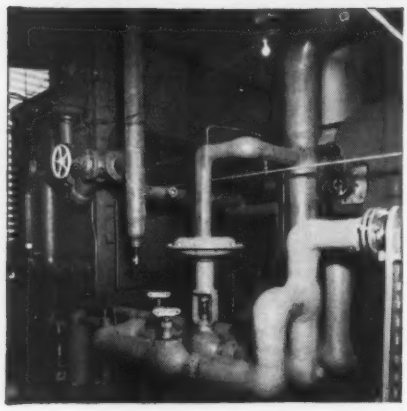
Moisture Analyzer. Consisting of two modules, Type THU electrolytic moisture analyzer measures moisture in refrigerant gases. Continuing a thermostat, the gas sampling module includes a vaporizing valve and oil separator with all components required for accurate measurements. Either ac or battery-operated, the indicating and control module gives continuous indication of moisture in ppm of water by volume. Information is provided by Flyer DS-1070.
Manufacturers Engineering & Equipment Corporation, York and Sunset Lane, Hatboro, Pa.

Overhead Gas Heaters. For industrial and commercial buildings, these heaters beam infra-red rays down in a wide, even circular pattern. Operating on either natural or LP gas, they are available with thermostats for automatic operation. Input is 35,-100 Btu/hr. Information is presented in a four-page bulletin.
Space-Ray Corporation, P. O. Box 3485, Charlotte 3, N. C.

Silencers. In addition to showing acoustic performance of Quiet-Duct silencers, this catalog lists the performance of more than 44 unit sizes and 90 multiple unit sizes by airflow (from 185 to 372,000 cfm) and pressure drop (from 0.1 to 1.50 in.).
Industrial Acoustics Company, Inc., 341 Jackson Ave., New York 54, N. Y.

Line Strainer Guide. Shown in four-page Bulletin J-LS are steam and liquid strainers available in aluminum (¾ to 4 in.), stainless steel (½ to 2 in.), cast iron (¼ to 6 in.), bronze (¼ to 4 in.) and cast steel (¼ to 4 in.). Also contained in the guide are strainer tips for better performance, recommended mesh to use and extensive engineering details, including fea-

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PRECISELY AS YOU NEED IT



NIAGARA CONTROLLED HUMIDITY AIR CONDITIONING

removes atmospheric moisture by direct contact with an absorbent liquid in a compact spray chamber. The spray contact temperature and the concentration of the absorbent liquid, two factors that are easily controlled, determine precisely how much moisture remains in the air leaving the unit.

This Niagara Controlled Humidity method, using Niagara Hygrol Absorbent Liquid is....

The only really precise method of air conditioning because it removes moisture as a separate function from heating or cooling to give you assurance of accuracy of air moisture control.

It is the most reliable because the absorbent is continuously and automatically kept at the proper concentration. No moisture-sensitive instruments are required to control your conditions.

It is the most flexible because with it you can either hold the precise condition you need as long as you wish or vary it with accuracy.

It is easiest to operate and maintain because the equipment and controls are simple and trustworthy.

This method is successfully used in the storage, testing and production of hygroscopic materials, in process control and as a pre-dehumidifier in comfort air conditioning.

Write for Bulletins Nos. 122 and 140.
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tures, photographs, dimensions, mesh availability and particle retention capability, and charts showing ratios of screen open area to inside pipe area for all sizes and screen mesh.
OPW-Jordan Corporation, 6013 Wiehe Rd., Cincinnati 13, Ohio.

Pipe Thawing. Data on fast, safe thawing of frozen water pipes with low voltage electricity are contained in eight-page Bulletin EW-243. Subjects covered include electric method, types of equipment, instructions for thawing and safety suggestions. Typical pipe thawing connections for use on residential, farm and industrial piping are illustrated. Tables show amp and time required for thawing, recommended cable sizes and maximum amperage loads of preferred arc welding equipment.
Hobart Brothers Company, Troy, Ohio.

Multiple Circuit Connectors. Featuring high amperage ratings with low insertion and extraction forces, Ampeez connectors are the subject of Flyer 341. Photographs and a general description of the units are presented, and potential applications in the appliance, electrical, electronic and power equipment fields are discussed.

Features of the brass contacts, each of which require only two to five lb insertion and extraction force, are listed on the front of the bulletin. Detailed specifications for the receptacle and tab housings and for the contacts are given on the second page.
AMP Inc., Harrisburg, Pa.

Air Blender. For high velocity, double-duct air conditioning systems, "Twin-Duct Air Blenders" are introduced in Catalog 1100-B107. Explained is how the new ceiling and under-window air blenders operate without the use of motors, piston operators or mechanical linkage. Given in the bulletin are selection and performance data, dimensional drawings, design features and detailed engineering information on specifications and noise levels. Also included are system advantages and unit features.
Worthington Corporation, Air Conditioning Div, Ampere Station, East Orange, N. J.

Flexible Metal Connectors. Designed for most hydronic installations, as risers, drop lines and end of runs, flexible metal connectors and nipples are cited as saving on fittings and time-consuming assembly of parts, taking up expansion and contraction and permitting assembly by hand. Specifications and other data are included in four-page Catalog HC88.

Pump connectors and hydronic flex couplers are the subject of four-page Catalog PC77. Units are designed, engineered and constructed to provide flexibility for absorbing vibration, shock, impact, expansion or contraction of pipe resulting from thermal or pressure changes.
Cobra Metal Hose, 5059 S. Kedzie Ave., Chicago 32, Ill.

Pumps. Featuring a wide range of pump types, sizes, capacities and pressures, the UV line is designed for return of condensate to the boiler or other points from varied types of steam heating systems or process equipment. General information, construction, engineering data and a capacity table are presented in four-page Bulletin 19-B.

Type CCVS pumps are featured in four-page Bulletin 21-C, which gives product illustrations, features and construction.
Skidmore Corporation, St. Joseph, Michigan.

Refrigerators, Refrigerator - Freezers. Ranging from 9.3 to 13.4 cu ft, electric refrigerators in this 1961 line feature large freezer areas, natural draft condenser to provide cold without jet air blasts and aluminum freezer liner, ice trays and door shelf guards. Model SC45B is presented in Flyer K-40-CL and Models SD45B, SD55B and SD65B in four-page Bulletin K-41-CL.

Two-door compact electric refrigerator-freezers are also detailed in two bulletins, Model CK55B in Flyer K-42-CL and Models CK65B, CL65B and CW65B in four-page Bulletin K-43-CL. Featured are automatic defrost, large door shelves, magnetic seal door gasket and a Coldcoil against the back wall of the refrigerator compartment to retain food freshness.
Hotpoint Div, General Electric Company, 5600 W. Taylor St., Chicago 44, Ill.

Industrial Electric Heating Equipment. Axial flow and centrifugal blower unit heaters, longitudinal fin elements and duct heaters, controls, bracket-type explosion-proof convectors, automatic unit ventilators, tubular elements, industrial radiant heaters, liquid storage heaters, water and oil immersion heaters, heater elements, and side arm and high capacity liquid, swimming pool, strip, fin strip and cartridge heaters are among equipment listed in 36-page Catalog IEH-2. Wiring diagrams, dimensions, product

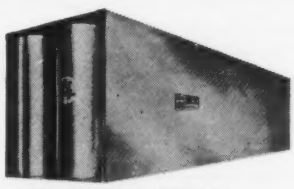
Fan Noise CONTROLLED in Air Handling Systems QUICKLY & ACCURATELY in less than 5 minutes!

Recognition that noise generated by fans in air handling systems could be predicted and controlled has led to a series of developments in both the "calculations" and also the necessary noise control equipment.

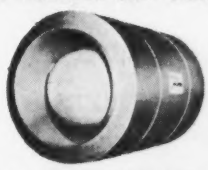
Guesstimating has now been eliminated by the general acceptance of these 4 important steps, functions and/or considerations: (1) that the total fan noise and its spectrum is substantially per the ASHRAE GUIDE dated 1957 or later (2) that we now have workable data covering the natural noise reduction due to ductwork, elbows, splits, distances, end reflections, room absorptions, etc. (3) that we have NC and NCA criteria for each of the 8 octave bands for most types of areas and we can now specify what is desired, and more important, by using an octave band analyzer, it can be readily determined whether the specified criteria has or has not been met (4) the development of prefabricated noise reduction units (noise traps, sound traps, etc) which have been properly factory tested and rated so they can be used with the method mentioned above.

"Short Form" Makes Selection Easy

Since that time, because of the progress made in the design of Quiet-DUCT Silencers, and the wide acceptance of newly developed techniques mentioned above, the "Short Form" has been developed to make the selection of unit silencers for air handling systems an easy matter.

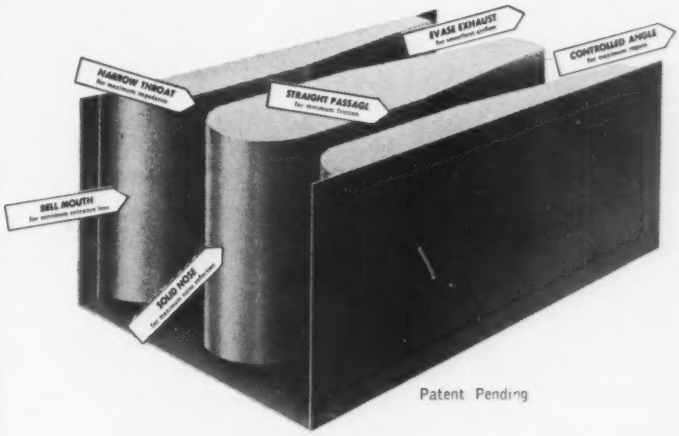


QUIET-DUCT SILENCERS
4 STANDARD MODELS
4 LOW PRESSURE MODELS
44 UNIT SIZES
90 MULTIPLE UNIT SIZES



CONIC-FLOW SILENCERS
18 STANDARD UNIT SIZES

"Cut-Away" View Reveals New Design of "Packaged" Quiet-DUCT Silencers.

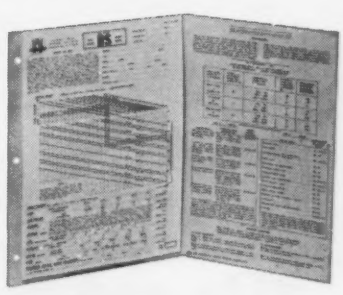


Patent Pending

Over ten years of experience in controlling noise in air handling systems has resulted in this new, basic design for all "packaged" silencers manufactured by our company. Design requirements include: *Bell Mouth Entrance* for minimum air pressure loss; *Solid Nose* for maximum noise reflection; *Narrow Throat* for maximum noise impedance. *Straight Passages* provide smoother airflow with more silencing and less regenerated noise. *Less Pressure Drop* is achieved by the diverging design of the evasé exhaust, keeping turbulence at a minimum and attaining maximum pressure regain.

The "SHORT FORM" consists of a small binder containing a pad of 25 reproducible work sheets. Only one such sheet is necessary to quickly and accurately resolve each noise problem and determine whether silencers are required, and if so, the silencer model needed to provide the Noise Reduction required for the problem. The "SHORT FORM" gives the Noise Reduction required in the 3rd octave band (in decibels) based on the data and procedures published in the ASHRAE GUIDE & DATA BOOK. Many field experiences have demonstrated that 3rd band calculations, by themselves, are a reliable index to silencing requirements as related to air handling systems. Because of the inherent characteristics of the "packaged" Quiet-DUCT silencers — if silencing is required in the 3rd Band, and the unit silencer is selected based on this criteria, more than enough noise reduction will be provided for all other bands as well.

The "SHORT FORM" is available through our representatives or write direct.



IAC
Your Standard of Silence

INDUSTRIAL ACOUSTICS COMPANY, INC.

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illustrations, operating temperatures and specification information are given.
Wesix Electric Heater Company, 390 First St., San Francisco 5, Calif.

Heavy Duty Air Handlers. Central system air conditioners in a size range from 3 to 92 nominal ton are introduced in Flyer J-0531. Features of the air handlers and coils are described and accessories are pictured. Given in a condensed chart are data on capacities, air quantities and available face areas of coils for the various sizes of suspended and floor mount models.
Halstead & Mitchell Company, Bessemer Bldg., Pittsburgh 22, Pa.

Smoke Alarm. Guarding against smoke circulated by an air conditioning system, this alarm shows the density of gases on a meter. At any predetermined volume of light cut-off, the unit will shut down the fan and flash a red danger signal. If desired, an audible signal may be added. Descriptive of the unit is Bulletin 553.
Photomation, Inc., 96 S. Washington Ave., Bergenfield, N. J.

Portable Heaters. Cylindrical perforated stainless steel heat exchanger surrounds a large cast-iron burner. Intensely hot combustion gases are forced out through tiny holes in the heat exchanger, causing it to glow red-hot and radiate heat over a wide area. Units are available in 50,000 and 100,000-Btu/hr sizes and are described in a four-page bulletin.
Bright Leaf Industries, P. O. Box 3115, Charlotte 3, N. C.

Baseboard Radiation. Four-page Catalog BB-60 gives extensive rating, dimensional and working data on type 485 baseboard radiation and accessories. Illustrations show the new silent roller bearing support for the finned tube heating element.
Rittling Corporation, Buffalo 5, N. Y.

Truck Refrigeration. Kold-Hold holdover plates, Crest condensing units and an extensive line of accessories are presented in Catalog K-61. Fully illustrated, the bulletin describes product construction and operational features and provides engineering data for selection, installation and use of truck refrigeration equipment. Accessory items include package expansion valve-drier-heat exchanger-moisture indicator console panels, mounting brackets, gauges, thermometers, liquid and moisture indicators, make-and-break connections and expansion valves.
Tranter Manufacturing, Inc., Lansing 9, Mich.

Portable Duct. Specifications of lightweight, rugged, portable duct, designated Spiratube and used for ventilation, materials handling and fume and dust removal systems, are presented in a four-page bulletin, "Facts About Spiratube." Construction and uses are described.
Flexible Tubing Corporation, Guilford 2, Conn.

Metering System. Comprised of a magnetic flowmeter (either standard or miniature type) and an indicator/recorder which can measure fluids with conductivities as low as 0.1 micromhos/cm, this metering system is discussed in eight-page Specification 10D1410B.

Factual information is given on materials of construction, mounting, capacities of the primary element, secondary readout and on dimensional drawings and wiring diagrams for the system.
Fischer & Porter Company, 743 Jacksonville Rd., Warminster, Pa.

NEW! Waterproof!



NOW STANDARD ON ALL REGULARLY CATALOGUED JE SOLENOID VALVES

New epoxy-clad coils are line-tested at 2300 volts completely submerged in water. Eliminate coil failure! Impervious to almost anything and everything—condensation, fluid spray, frost, oil, gasoline and other corrosive liquids and vapors. Unlimited indoor or outdoor applications. U.L. listed. Wire, write, or phone:

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Soon you can have it! HI-PRESS AIR CONDITIONING OF AMERICA, INC., pioneer developer of small-pipe-high-velocity air systems used in over 500 ships the world over, is fast readying this revolutionary concept for adaptation to a multitude of industrial/commercial applications on Land. (Pssst... listen! This small, twin-pipe system requires half the space needed for conventional ductwork; special pipe and fittings are Aerodynamically designed, noise attenuating; special clamping device gives leakless construction.)

A MOST IMPORTANT NEW TEAM IN ALL THE INDUSTRY

On December 15, 1960, the big news broke... about our spirited new combo: HI-PRESS and DRAYER-HANSON, who then became a Division of Hi-Press. This most logical welding of two key names constitutes a 500% growth factor. It means limitless facilities, talent, "know-how" are high-gearing to give you all the excitement noted above, plus a bold, broad line-up of air conditioning and refrigeration products to thoroughly "pace-set the Sixties." D-H—since 1910 a leading designer/manufacturer of quality air conditioning and refrigeration! HI-PRESS—the big name in Marine air conditioning. Watch us GO!

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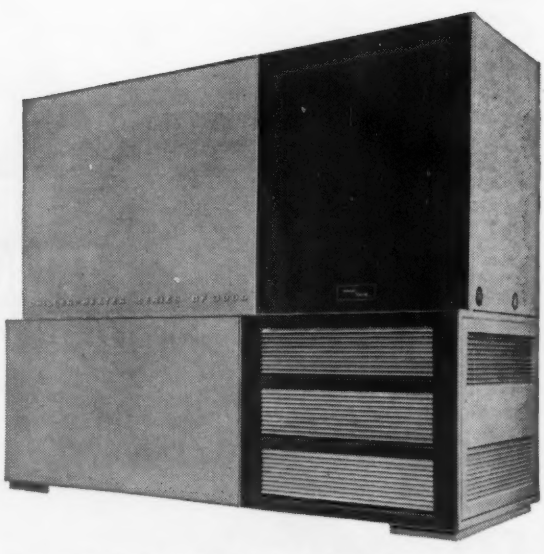
THE MOST URGENT THING FOR YOU TO DO RIGHT NOW...

If you are: (1) "itching" for details, (2) have even a remote interest—Get to Chicago, February 13th through 16th! Or, keep your eye on The 15th International Heating & Air Conditioning Exposition. We'll "peek-preview" these exciting developments—Booth #1172—under the proud new banner of HI-PRESS AIR CONDITIONING OF AMERICA and DRAYER-HANSON DIVISION, HI-PRESS. Meanwhile, call a Drayer-Hanson sales agent near you or receive the Full Facts on our products by contacting us now.

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A MAJOR BREAKTHROUGH IN COOLING & HEATING

ARKLA'S NEW 25-TON GAS CHILLER-HEATER

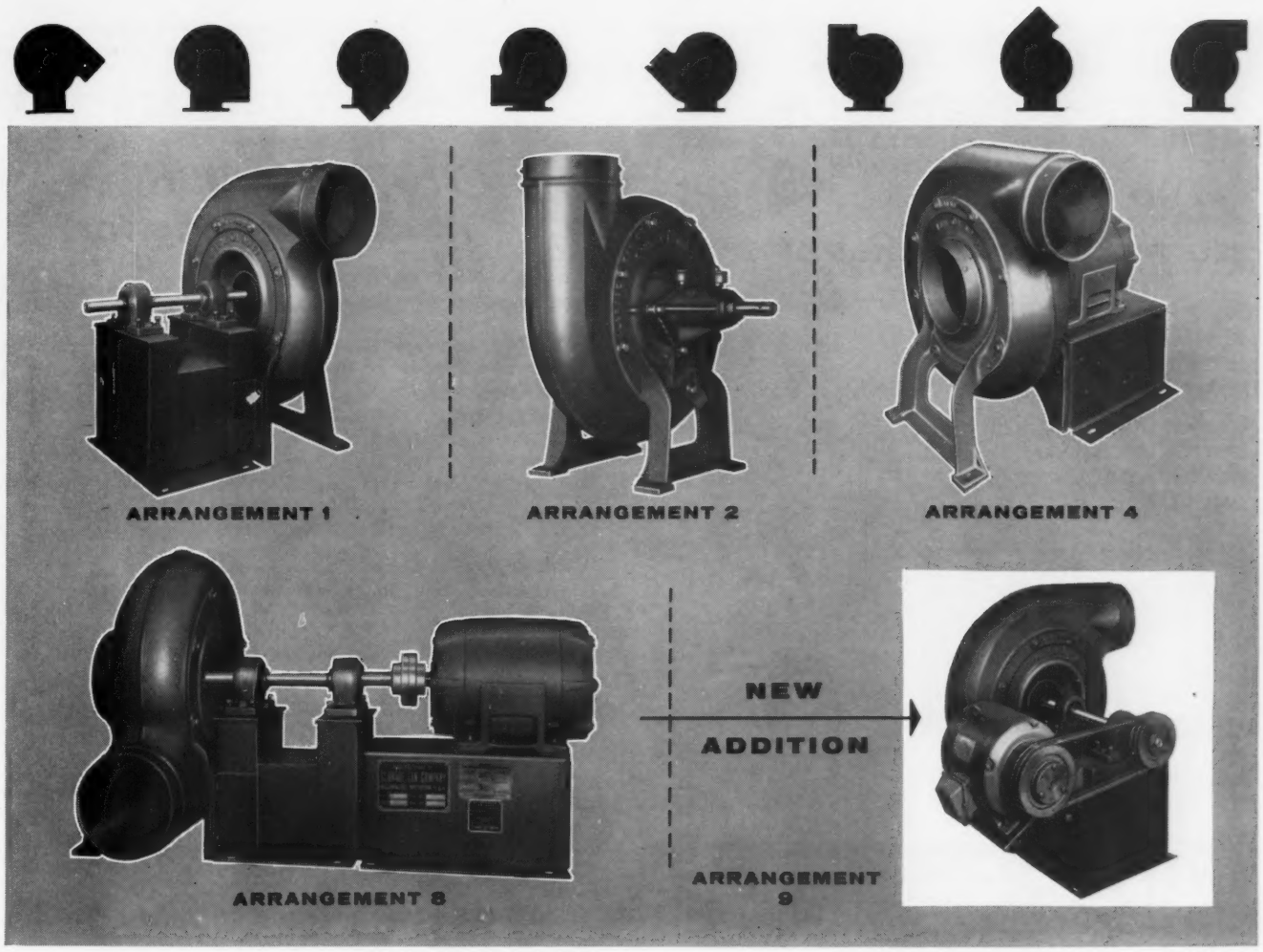


Here it is—the revolutionary new Arkla absorption unit that heats and cools without a steam producing boiler or converter. Gas-fired burners in the generator section energize the system for absorption cooling, or for heating. It's the perfect system for modern year 'round gas air conditioning.

INSTANTLY HEATS AND COOLS AUTOMATICALLY ■ HEATS WATER WITHOUT A BOILER ■ COOLS WATER WITHOUT A COMPRESSOR ■ REQUIRES NO LUBRICATION ■ SEALED FOR LIFE, REQUIRING MINIMUM MAINTENANCE ■ MAINTAINS SAME CAPACITY FOR THE LIFE OF THE UNIT ■ HAS NO MOVING PARTS IN THE HEATING AND COOLING CYCLE ■ FIRST MEDIUM OR LARGE TONNAGE AIR CONDITIONER THAT HEATS. Truly revolutionary . . . investigate for your next building project the new Arkla DF-3000 Gas-fired All Year® Chiller-Heater.

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Presenting... *the new line of CLARAGE Type CI Exhausters*

Volumes to 3800 CFM, pressures to 18″, temperatures to 750°F., six sizes, three wheel types, five arrangements as shown above, adjustable to any of the eight standard air discharge directions.

Result: fan equipment uniquely well suited to nearly every service imaginable. The uncomplicated, heavy construction, featuring cast iron housings and sideplates, makes the Type CI the natural selection for such severe applications as exhausting from grinding, woodworking, and other machines . . . conveying materials ranging from fibers to grains . . . removing smoke and fumes . . . furnishing industrial process air . . . handling chemical and hot gases.

Write for new Catalog 707 containing performance tables, dimensions, and system data. Get acquainted with the advantages you'll enjoy by choosing Clarage Type CI Fans for your next requirements. CLARAGE FAN COMPANY, Kalamazoo, Michigan.

Dependable equipment for making air your servant

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ACCESS SADDLE VALVE

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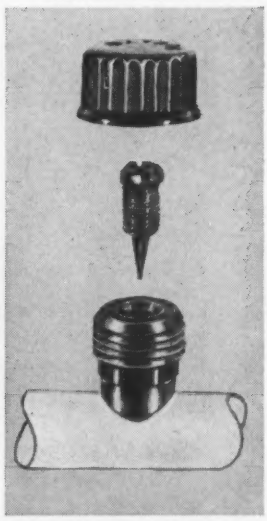
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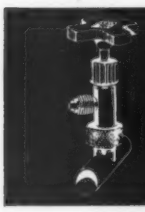
NO SEALING WASHERS!

Now a **Truly Hermetic** tube piercing valve can be soldered or brazed on refrigerant lines without removing the refrigerant!

Complete with silver solder preform, the Access Saddle Valve is available in the following O.D. tube sizes: 1/4", 5/16", 3/8", 1/2", and 5/8".

U.S. PAT. NO. 2,827,913





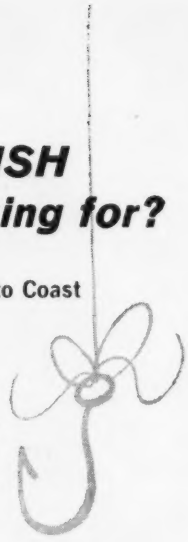
Use with Watsco control valve CV-1G or CV-2G.

For additional information ask your wholesaler or write to Dept. J-2

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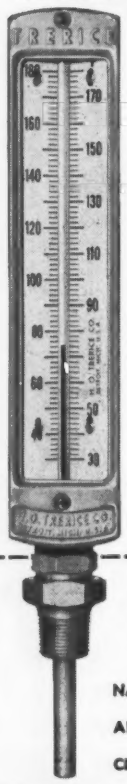
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MATERIALS FOR PROTECTION OF THERMAL INSULATION AGAINST FIRE DAMAGE

FIRST, to clear up a common misconception about materials used to protect thermal insulation; no coating, sealer, or adhesive can by itself prevent fire damage. In fact, certain products without fire-retardant properties many times will actually cause fire and flames to spread; while products containing fire-retardant properties can at best only retard the spread of flames by the reduction of available fuel.

Over the years many ambiguous and ill-defined terms have been used to describe fire resistant properties of materials in literature, specifications and other published data. Words and phrases such as incombustible, flame-proof, non-flammable, fire resistive, and even fireproof have been attached to products used for the protection of thermal insulation. In many cases where the use of these terms was based on unrecognized and inadequate test methods, the products actually fed fuel to the flames rather than retarding them.

The only accepted measure of fire hazard in coatings is the flame-spread value. The confusing phrases used above do not give in exact terms the flame-spread value. If the confusion is to be eliminated, Industry must adopt a standardized system of testing and terminology for use in Engineering Specifications.

The use of confusing terms can be discarded by the adoption of the rating standard known as the Flame-Spread Index, accepted and used by building codes and insurance underwriters. There are two test methods accepted by Industry for determining flame-spread values. These are the Underwriters' Laboratories' "Tunnel Test" (ASTM E84) and the National Bureau of Standards "Radiant Energy Test" (Interim Federal Standard .00136–Com. NBS). With either of these established methods, flame-spread values ranging from zero to over 200 can be determined with accuracy for all coatings, adhesives and sealers used with thermal insulation materials.

An example of flame-spread values:

A totally incombustible material such as portland cement would have a flame-spread value of zero, while a self-extinguishable synthetic resin product could be rated about 60, and a violently combustible nitrocellulose product would be rated at "over 200."

Here, also, are the flame-spread values of some popular insulation weathercoatings applied over calcium-silicate insulation:

VAPOR BARRIER ASPHALT MASTIC	
Product A	175
Product B	173
Foster C. I. Mastic 60-26	170
FIBRATED ASPHALT EMULSION MASTIC	
Product A	218
Product B	200
Foster H. I. Mastic 90-07	150
FIBRATED POLYMER EMULSION MASTIC	
Product A	290
Foster Sealfas Mastic	40
FIRE RESISTIVE VAPOR BARRIER MASTIC	
Foster Fire Resistive Mastic 60-60	35

The Solvent Problem

Flame-spread values of solvent type mastic weathercoatings are determined under solvent free conditions to simulate service conditions existing after the products have been applied and all traces of solvent have evaporated. However, during application and cure, a fire hazard will exist when flammable solvents are contained in the coating. Such solvents having a flash point lower than 100° F. are flammable and easily ignited by welding sparks, matches, electrical sparks, cigarettes, etc. Thus a product, whose flame-spread index under solvent free conditions is relatively low, could well be the cause of a disastrous fire while it is being applied if it contains a flammable solvent.

Therefore, for complete fire safety, where welding and other sources of sparks and flame cannot be avoided during application of coatings and adhesives, these products should be chosen not only for their ultimate flame-spread value, but also for their formulation with non-flammable solvents (for example, Foster Fire Resistive Mastics).

Recommendations

We urgently recommend that engineers who specify fire resistive coatings, sealers and adhesives for use with thermal insulation specify maximum acceptable flame-spread values and flash points of materials. Only by rigidly adhering to such specifications will owners, their inspectors, buyers and applicators obtain fire safe thermal insulation construction.

A Word of Caution

The mere publishing of a flame-spread value is insufficient evidence on which to choose a product. Where two products, equivalent in every other respect, are offered for fire safe service, a product with a flame-spread value of 6 should unquestionably be chosen over a product whose index is 44. *Relative* flame-spread values, then, become of vital importance in choosing fire-retardant products.

Purpose

We at the Benjamin Foster Company have been devoting many years to research, study, manufacture and promotion of fire safe products for use in the protection of thermal insulation. We have adopted a firm policy regarding our promotion of fire safe products which is:

"To cooperate with all interested individuals and organizations in the establishing of a standardized system of testing and rating true flame-spread value . . .

To publish information that will be factual and in accordance with accepted practices . . .

To avoid overemphasis of disaster conditions in the promotion of fire safety . . .

To continue our research and development of products with improved fire safe characteristics."

If there is any way we can be helpful to you or your organization in a better understanding of products for use in the protection of thermal insulation, please contact your nearest Foster Representative, or write Benjamin Foster Company, 4635 W. Girard Avenue, Philadelphia 31, Pa.

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DIVISION OF AMCHEM PRODUCTS

Mr. George Stewart, mechanical contractor for Jane Addams Elementary School, Melrose Park, Illinois, says:

"Honeywell stayed on to Jane Addams job to our



Mr. George Stewart, in the equipment room at Jane Addams Elementary School. The Honeywell panel behind him enables the building engineer to check the entire pneumatic control system.

check out the complete satisfaction"



JANE ADDAMS ELEMENTARY SCHOOL
Architect-Engineer: Kefer & Cronin, Chicago
Mechanical Engineer: Albert W. Marshall, Chicago
General Contractor: Louis Macro Co., Melrose Park, Illinois
Mechanical Contractor: Tropf Heating Co., Broadview, Illinois

At Jane Addams Elementary School, Honeywell servicemen stayed on the job long after the building was completed to make sure the temperature control installation operated perfectly

"Honeywell really came through for us on the Jane Addams job," says Mr. Stewart. "They saw that the temperature control equipment was delivered on time and installed on time. They turned in clear shop drawings of the temperature control system. They gave us good supervision during installation, then stayed on to thoroughly check out the system to make sure it worked well under actual school conditions."

At Jane Addams Elementary School, Honeywell installed Pneumatic Round thermostats on the wall of every classroom. On the wall, they feel temperature in the classrooms the way students do. And they are also more convenient to read and adjust to offset varying effects of weather, occupancy and student activities.

You can depend on Honeywell to help you do a quality job. Fine controls, accurate specifications, prompt delivery and supervised installations are assured with Honeywell on your team. And only Honeywell gives you a choice of all three types of control systems—pneumatic, electric and electronic. For further information, call your nearby Honeywell office. Or write Honeywell, Dept. AH-2-32, Minneapolis 8, Minnesota. *Sales and Service offices in all principal cities of the world.*



This is the Honeywell Round, the world's most popular thermostat. It enables teachers to adjust temperatures to fit specific learning activities.

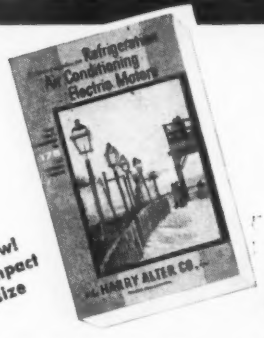
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SENIOR PROJECT ENGINEER—National brand manufacturer located in New York City seeks product designer for refrigeration and air-conditioning consumer appliances. Excellent opportunity for qualified man. Please state experience and salary requirements. Our employees know of this ad. Write Box AJ 1665, 125 W. 41st St., N. Y. 36, N. Y.

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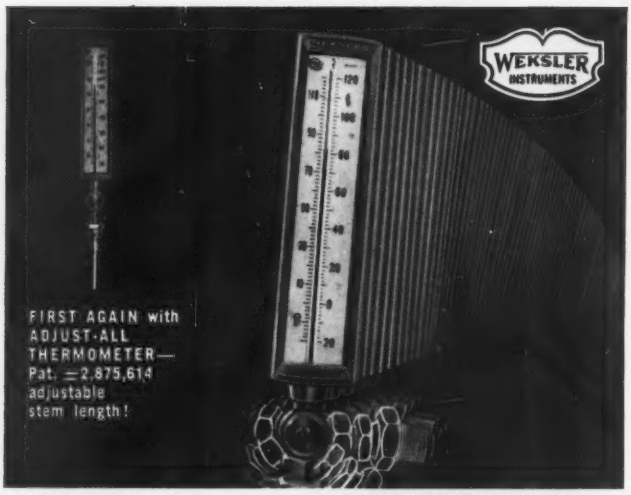
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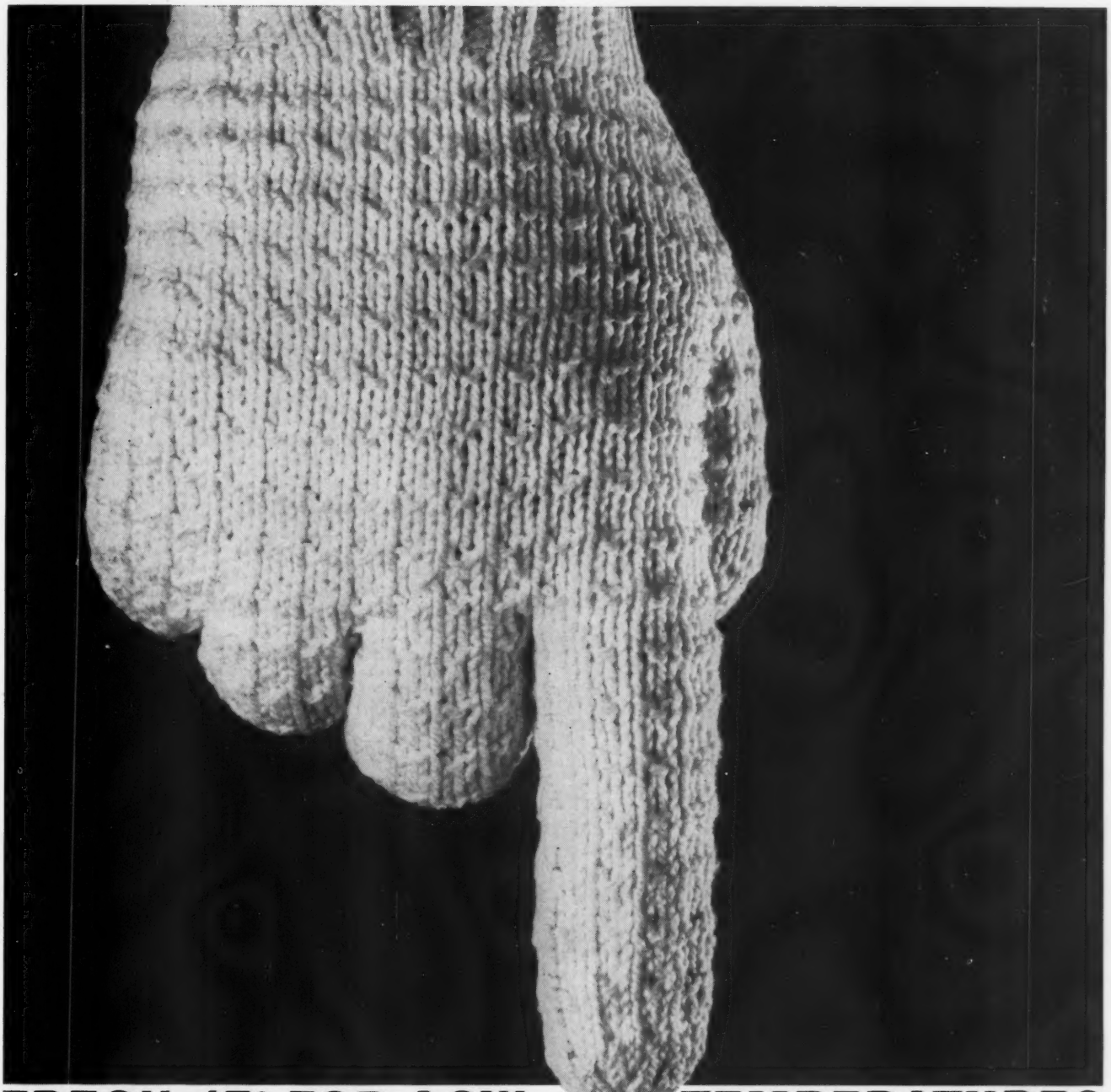
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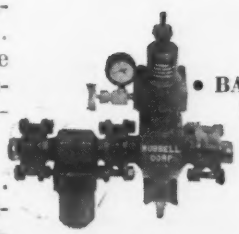
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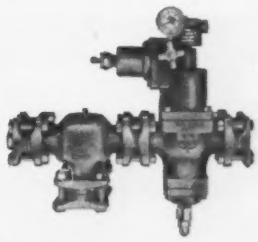
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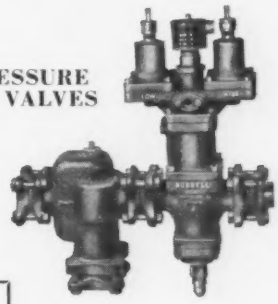
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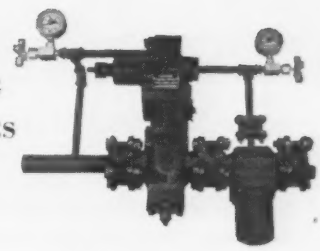


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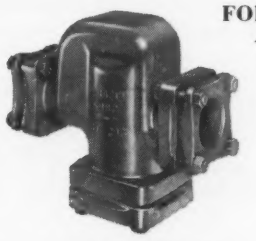


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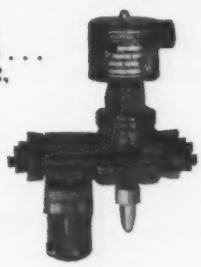


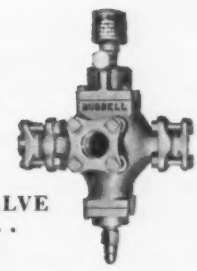
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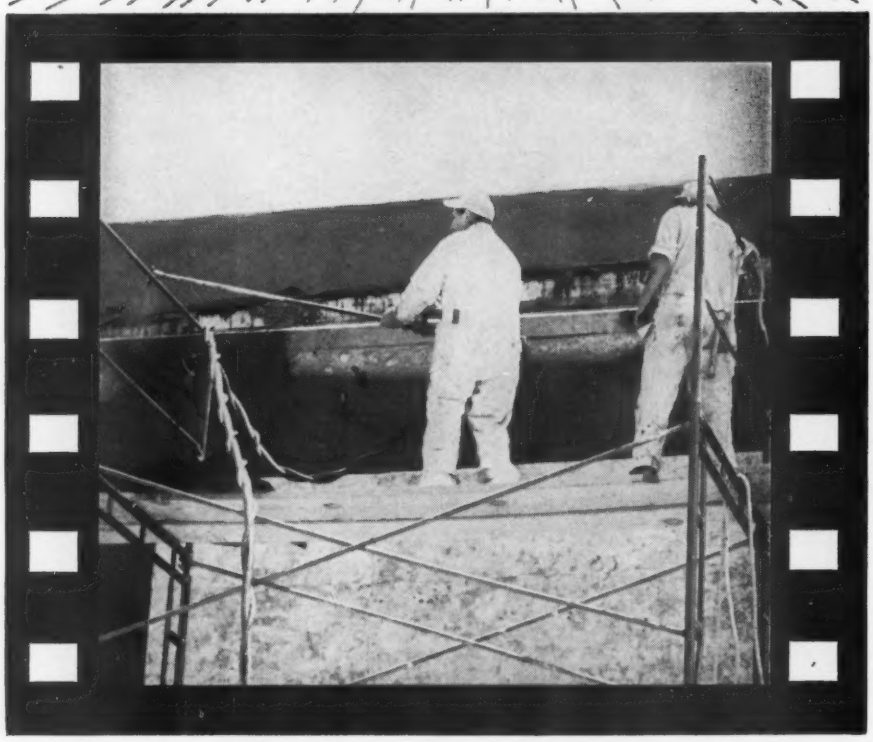
"Castings to finished controls . . . every inch HUBBELL!"

SPECIAL FEATURE

"INSULATED TILT-UP CONSTRUCTION"

STARRING

LAYKOLD INSULATION ADHESIVE



When builders applied the tilt-up technique to refrigerated warehouse construction, Laykold Insulation Adhesive was a "natural", adhering the vapor barrier membrane to the concrete wall panels. It also helps hold the glass-fiber blanket insulation.

Here's the way a tilt-up job goes:

1. Pour wall panel on floor and let set
2. Spray on Insulation Adhesive at 23 sq.ft./gal. It helps cure the concrete.
3. Press the vapor barrier membrane into the set Adhesive.
4. Tilt the panel up into position and anchor.
5. Spray Insulation Adhesive over membrane at 23 sq. ft./gal.
6. Press blanket-type insulation into place.

The speed and ease of this operation underscores the major advantages of Laykold Insulation Adhesive: *Spray-applied . . . cold . . . it saves time, equipment, money!*

Now Available:
a 15-minute, color-and-sound, 16mm motion picture of a tilt-up job. Ideal for employee groups or association meetings. Write for details. No charge, no obligation.

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New S. S. Kresge Variety Store, Haddonfield, N. J. Consulting Engineer: Charles Barrows, Levittown, Pa.; Air Conditioning Contractor: John P. Murdoch Co., Philadelphia, Pa.

Chrysler Air Conditioning says "welcome" 1500 times a day at new S. S. Kresge store!

S. S. Kresge Variety Stores do a land-office business in everything from balloons to barbecues. No exception is Kresge's new store (in the Ellisburg Circle Shopping Center) where Chrysler Air Conditioning bids a cool welcome to an average of 1500 shoppers daily.

With that number of people passing through the entrance doors—plus the fact that the entire front of the store is a continuous expanse of glass—it takes 70 tons of air conditioning to cool the 16,800 sq. ft. sales area.

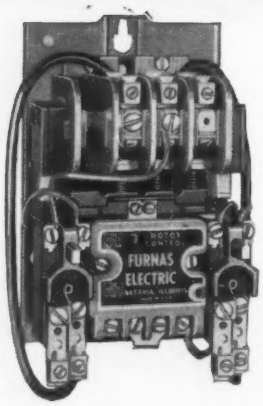
At the heart of the system is a Chrysler compressor mounted atop a raised floor to the rear. Installing the equipment above ground level provides room for storage beneath, thus answering another demand that all space be used to best advantage.

Chrysler efficiency, compactness, and flexibility as demonstrated here can help solve your air conditioning problems, too. For more facts and figures on Climate by Chrysler, or the technical cooperation of a Chrysler Air Conditioning Engineer, write today.

CHRYSLER AIRTEMP

Airtemp Division, Chrysler Corporation, Dept. V-21, Dayton 1, Ohio
In Canada: Therm-O-Rite Products, Ltd., Toronto, Ontario

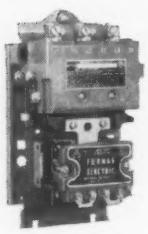
new CURRENT RATED STARTERS



Through 53 amps, rated in full load and locked rotor. Can be used for both 220 volts and 440 volts.

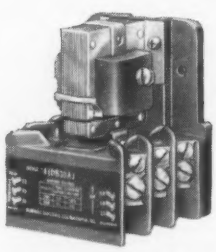
new CURRENT RATED CONTACTORS THROUGH 90 AMPS.

Furnas Electric offers a complete line of current rated contactors through 90 amps meeting requirements of the Air Conditioning and Refrigeration Industry.



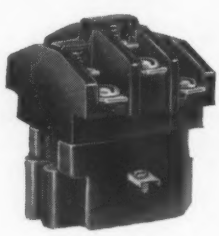
90 amperes

Contactors through 40 amps, 2, 3 and 4 pole with interchangeable mounting dimensions are available for compressor and electrical heating applications.



40 amperes

2 and 3 pole, 25 amp contactors are used for unattended domestic and commercial applications, and for resistance heating applications.



25 amperes

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BATAVIA, ILLINOIS

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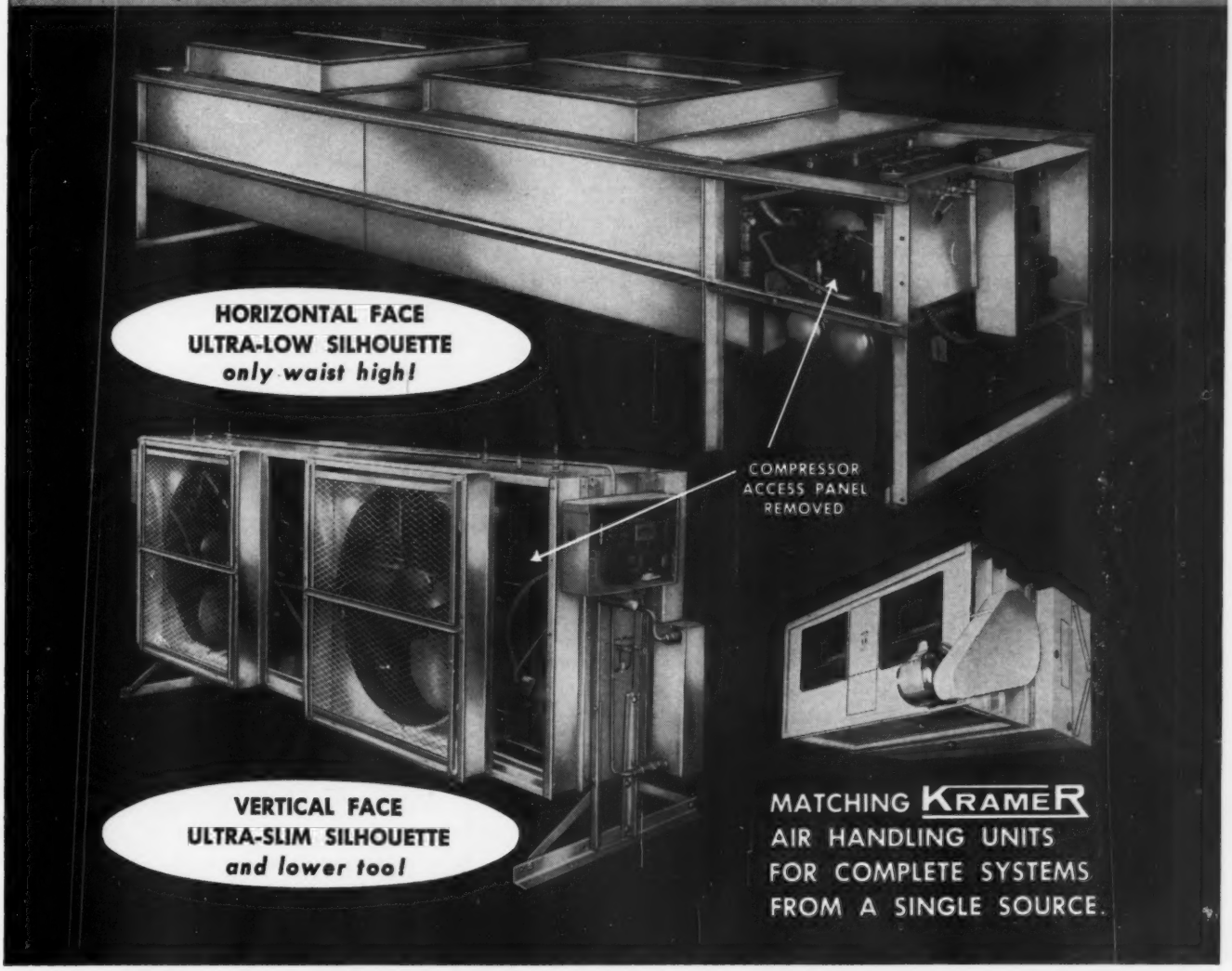
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From the leader in air-cooled condensing

the new KRAMER UNICON-COMPRESSOR

PACKAGED *WATER-FREE* CONDENSING UNIT



3 *to* 70 TONS—HORIZONTAL *or* VERTICAL FACE

The low, slim-trim lines of the new Kramer air-cooled UNICON-COMPRESSOR give it unequaled flexibility in any architectural setting. Space saving outdoor design and low, low operating weight combine to reduce structural and engineering problems. Easy and economical to install, the complete packaged UNICON-COMPRESSOR has matchless accessibility for servicing. Its corrosion resistant aluminum casing, and its frame galvanized after fabrication, eliminate painting maintenance.

And remember—no place in the U. S. A. is too hot (or too cold) for the UNICON-COMPRESSOR. With the patented Kramer Winterstat it will operate any time of the year, without adjustment, even in the dead of winter.

Write for bulletin C460B.

KRAMER TRENTON CO., Trenton 5, N. J.

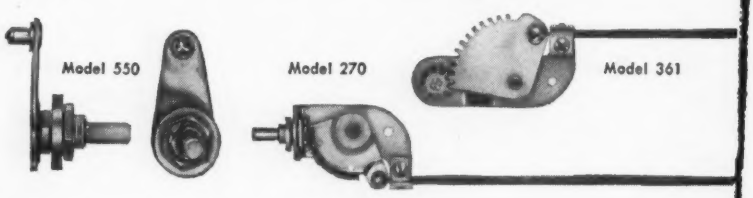
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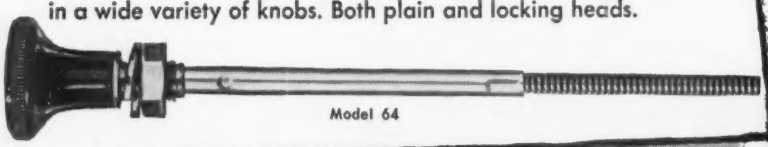
FOR DAMPERS, DOORS, PULLEYS

There are many standard-design Arens Controls for use in the heating and air-conditioning industry. These controls may offer you the most economical answer to your control requirements. Our research and engineering department also would be very happy to work with you on special design controls. Below are some typical Arens standard-design controls.

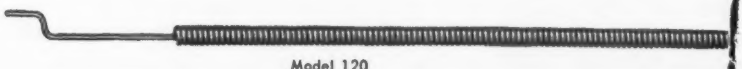
CONVERTER TYPE: Flush operation, rotary motion of knob gives linear travel to control. Compact, easy to install.



PUSH-PULL TYPE: Simple, effective, sturdy. Available in a wide variety of knobs. Both plain and locking heads.



CONNECTOR TYPE: Used to connect lever with device to be operated. Obtainable with many types of ends.



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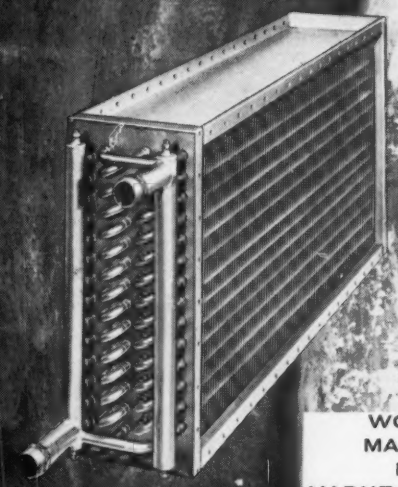


Equipment Had Demonstrated Its Quality and Dependability In Previous Installations

The "Project Mercury" space capsule, designed and built by McDonnell Aircraft Corporation to carry a man in orbit around the earth, is assembled in a "Super Clean White Room" operated under incredibly stringent environmental and hygienic conditions.

The air handling system serving this special chamber at the McDonnell plant is equipped with Marlo heating and cooling coils. Why was Marlo selected for this installation? McDonnell plant engineer George [illegible] says, "We had used Marlo equipment in a previous [illegible] room. Our complete satisfaction with the performance of their units, plus their ability to deliver to meet our tight production schedules answered our coil needs for our space capsule assembly room."

Whether it's an unusual installation like McDonnell's "Super Clean White Room", or an ordinary type of heating or cooling project, you'll find the coils you need in the complete Marlo line. The Marlo representative in your area can give you detailed information.



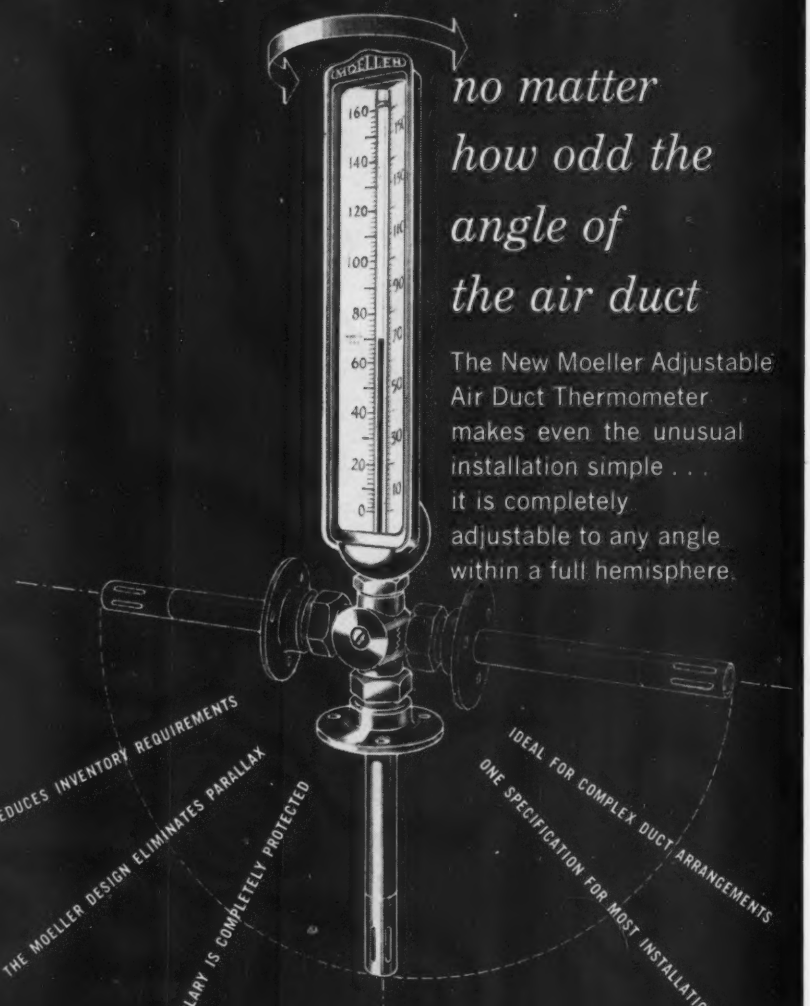
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- *7", 9" or 12" scales*
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15th International Heating and Ventilating Show, Chicago, February 13-16

Welcome to the Crane Booths (#825, 826, 829, 924, 927, and 928) when you visit the Show. What you'll see is all new plus—plenty of the Crane favorites you'll want to familiarize yourself with again. Crane representatives will be glad to discuss them with you . . . and their outstanding points of superiority that have made all Crane products leaders in distinctive design, fine engineering and meticulous manufacture. Welcome aboard! ■ Exhibited in the Crane Booths listed above will be Crane and National U.S. heating (both hydronic and warm air) and air conditioning products, Crane plumbing, Pacific Steel Boilers, Cyclotherm generators, Crane valves, Miami General Air Conditioning and Warm-air Heating as well as Swarthwout Systems and Controls.

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ARKLA'S NEW 25-TON GAS CHILLER-HEATER



Here it is—the revolutionary new Arkla absorption unit that heats and cools without a steam producing boiler or converter. Gas-fired burners in the generator section energize the system for absorption cooling, or for heating. It's the perfect system for modern year 'round gas air conditioning.

INSTANTLY HEATS AND COOLS AUTOMATICALLY ■ HEATS WATER WITHOUT A BOILER ■ COOLS WATER WITHOUT A COMPRESSOR ■ REQUIRES NO LUBRICATION ■ SEALED FOR LIFE, REQUIRING MINIMUM MAINTENANCE ■ MAINTAINS SAME CAPACITY FOR THE LIFE OF THE UNIT ■ HAS NO MOVING PARTS IN THE HEATING AND COOLING CYCLE ■ FIRST MEDIUM OR LARGE TONNAGE AIR CONDITIONER THAT HEATS. Truly revolutionary . . . investigate for your next building project the new Arkla DF-3000 Gas-fired All Year® Chiller-Heater. For details contact your local Gas Company. Or write Arkla Air Conditioning Corporation, 812 Main Street, Little Rock, Arkansas. *American Gas Association*

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